ENGIN STORAGE

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The Blast Furnace and Steel Plant

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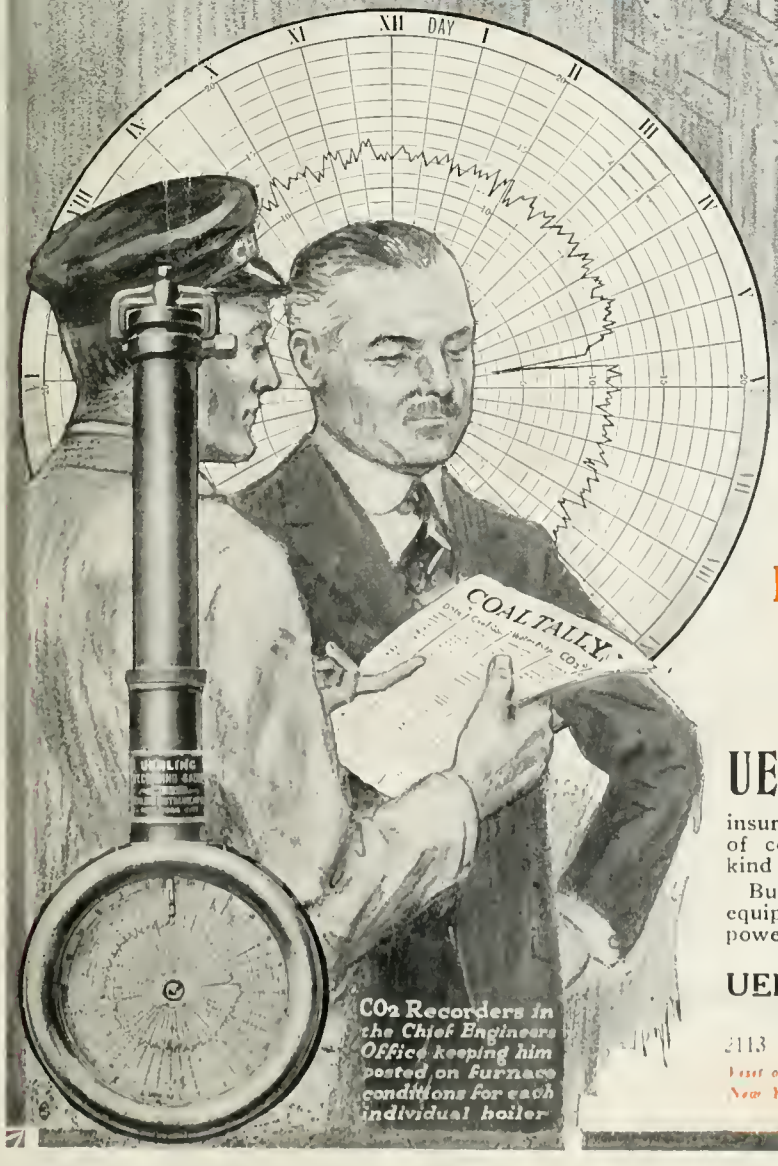
UNIVERSITY OF TORONTO
ENGINEERING

Pittsburgh, September, 1920.

Uehling CO_2 Equipment



CO_2 Recorders in the Chief Engineers Office keeping him posted on Furnace conditions for each individual boiler

CO_2 Indicator at boiler front to guide the fireman

Maximum Furnace Temperature Requires Correct Air Supply

UEHLING EQUIPMENT

insures correct air supply for any process of combustion, any type of furnace, any kind of fuel.

Bulletin No. 111-E, descriptive of our new equipment, should be in the hands of every power plant engineer and metallurgist.

UEHLING INSTRUMENT CO.
Combustion Engineers
2113 Empire Bldg. New York

Visit our Exhibit at Chemical Show, Grand Central Palace New York Week of September 20.

Specialized efficient handling of materials has been a large factor in making steel the world's largest industry—

—and advanced dump car engineering for economical waste material disposal is no small factor in helping many steel plants to front rank

—advanced dump car engineering does many things:

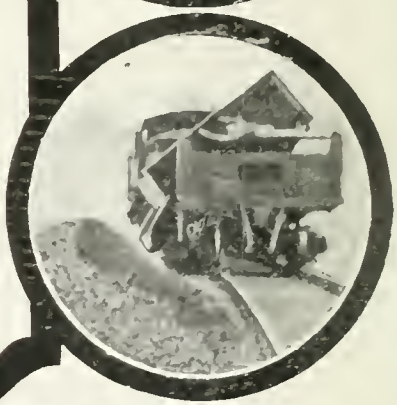
eliminates the scarce and slow and costly labor commonly used to empty cars of waste—dumps anything dumpable in 100,000 lb. loads

—eliminates time—so valuable in steel mill operation—by the extension side dumping—the train crew can dump one or a train of cars at once. The rapid train trips free locomotives and cars for other work about the plant.

eliminates labor after dumping—the unobstructed discharge over the down turning doors sends the load well out from the trucks and track—train clearance maintained without after dumping labor.

—The Extension Side Dump Car fills the long felt want of waste disposal—eliminates this problem from the worries of the "chief."

—We believe in them—because we can show you where they are doing big work every day.



Clark Car Company

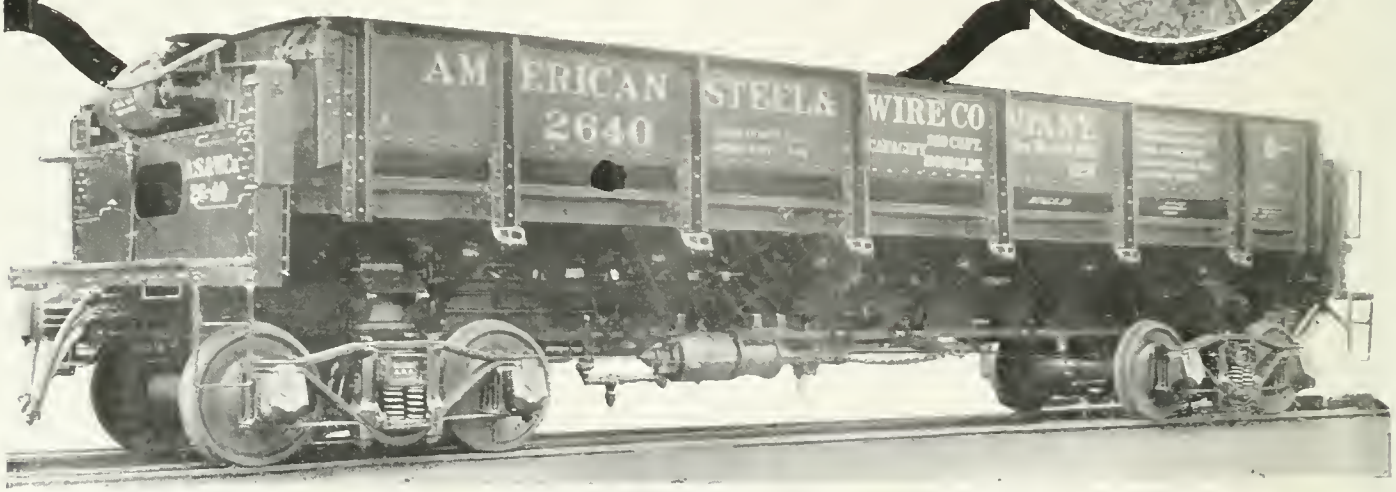
Pittsburgh

Chicago
Peoples Gas Bldg.

Salt Lake City,
Felt Bldg.

Boston,
53 Atlantic Ave

PITTSBURGH

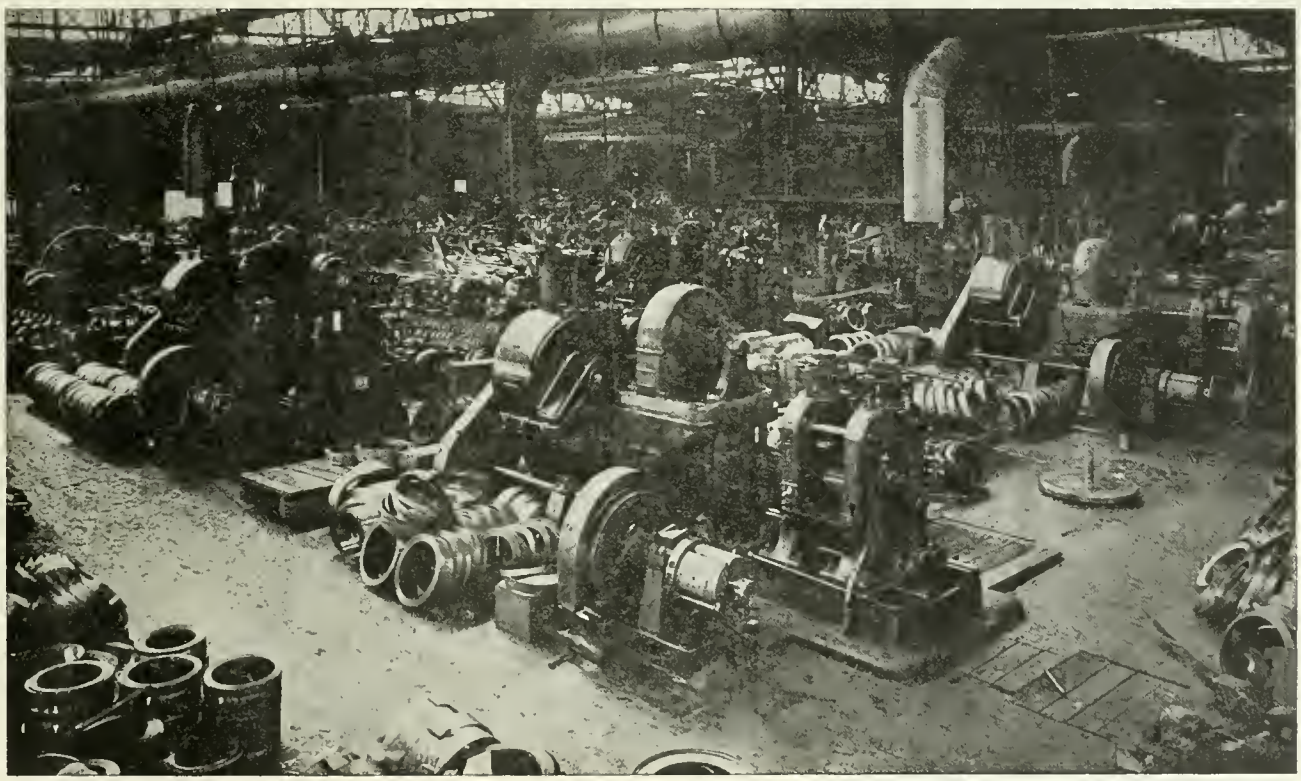


CLARK CARS

EXTENSION SIDE DUMP

Co-operate:—Refer to The Blast Furnace and Steel Plant

"UNITED"
PRECISION
COLD STRIP MILLS



The above picture shows some of the fourteen "United" 12" x 16" Cold Strip Mills in action at the plant of the Weirton Steel Company.

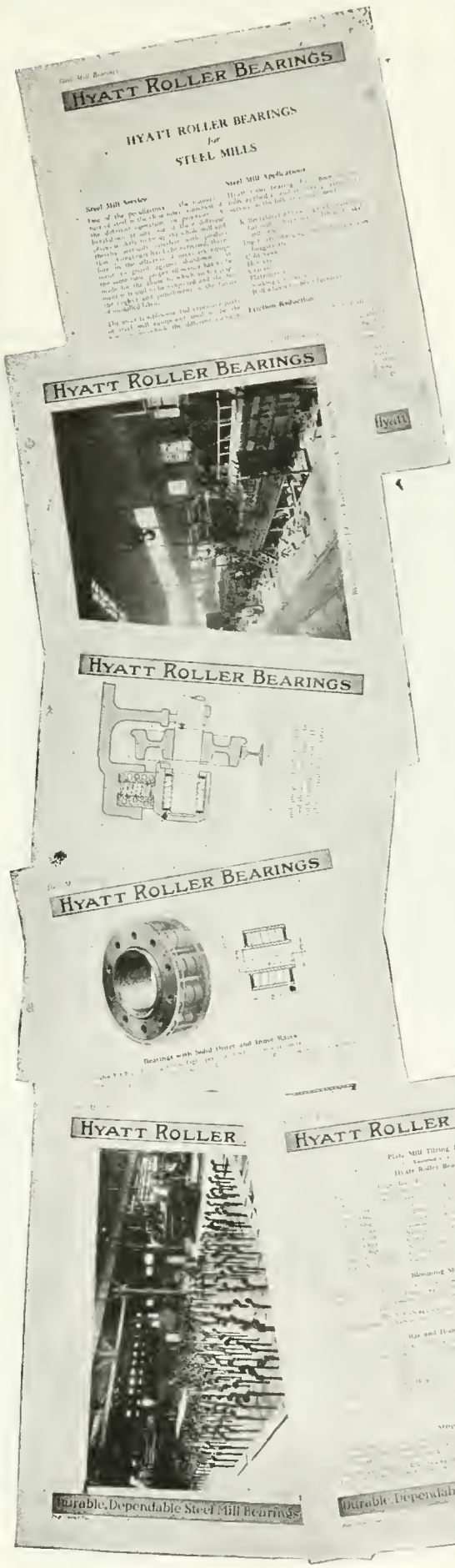
Note how the floor space is utilized around these machines. Saving floor space is only one of the many points of superiority the "United" Mills possess.

Our mills are comparatively more expensive than others but repeat orders from old experienced operators insures us that the extra cost is justified.

Our Strip Mill Bulletin P-1 Gives Valuable Information on "UNITED" Mills.

United Engineering & Foundry Co.
Pittsburgh, Pa.

The World's Greatest Manufacturer of Rolls and Rolling Mill Machinery



SIGN YOUR NAME AND

A new steel mill bulletin has just been issued by the Hyatt Roller Bearing Company containing—

24 Pages—of practical information for Steel Mill Engineers.

Designs—showing how Hyatt Roller Bearings are applied to charging and ingot cars, steel mill trucks, yard cars, blooming mill approach tables, plate mill tables, hot saws, plate castors and bull wheels.

Load Tables—giving the sizes of bearings, their numbers and the load capacity per bearing at different speeds. How the bearings are selected and mounted is fully described.

A List of Manufacturers—who build Hyatt Roller Bearing equipped steel mill equipment and who will be glad to quote on your requirements.

A List of Satisfied Users—of Hyatt equipped steel mill equipment.

Sign your name and address in the blank space opposite, tear out the page, mail it to us and you will get a bulletin which will make a worth-while addition to your library.

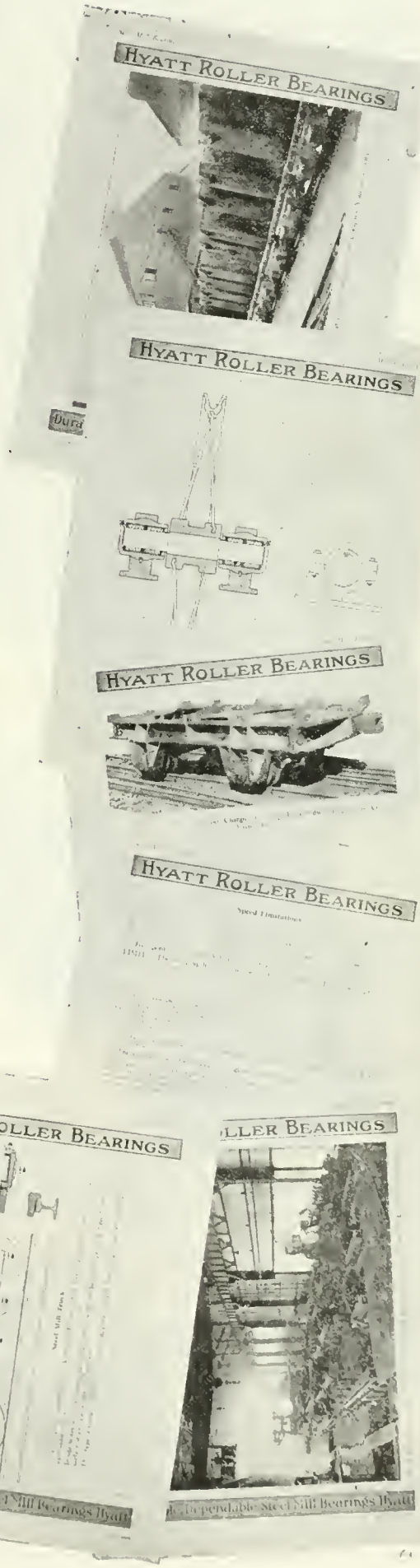
A-1814

HYATT ROLLER BEARING COMPANY
INDUSTRIAL BEARINGS DIVISION
NEW YORK, N. Y.

Co-operate:—Refer to The Blast Furnace and Steel Plant

MAIL THE PAGE TO US

Sign your name and address in the blank space below, tear out the page and mail it to us. You will get a copy of our new Steel Mill Bulletin No. 1825.


HYATT ROLLER BEARINGS
HYATT ROLLER BEARINGS
HYATT ROLLER BEARINGS
HYATT ROLLER BEARINGS
HYATT ROLLER BEARINGS
Power Saving · Ideal Lubricating · Durable
HYATT ROLLER BEARING CO. NEW YORK
STEEL MILL BEARINGS
Durable, Dependable Steel Mill Bearings-Hyatt
HYATT ROLLER BEARINGS
Durable, Dependable Steel Mill Bearings Hyatt

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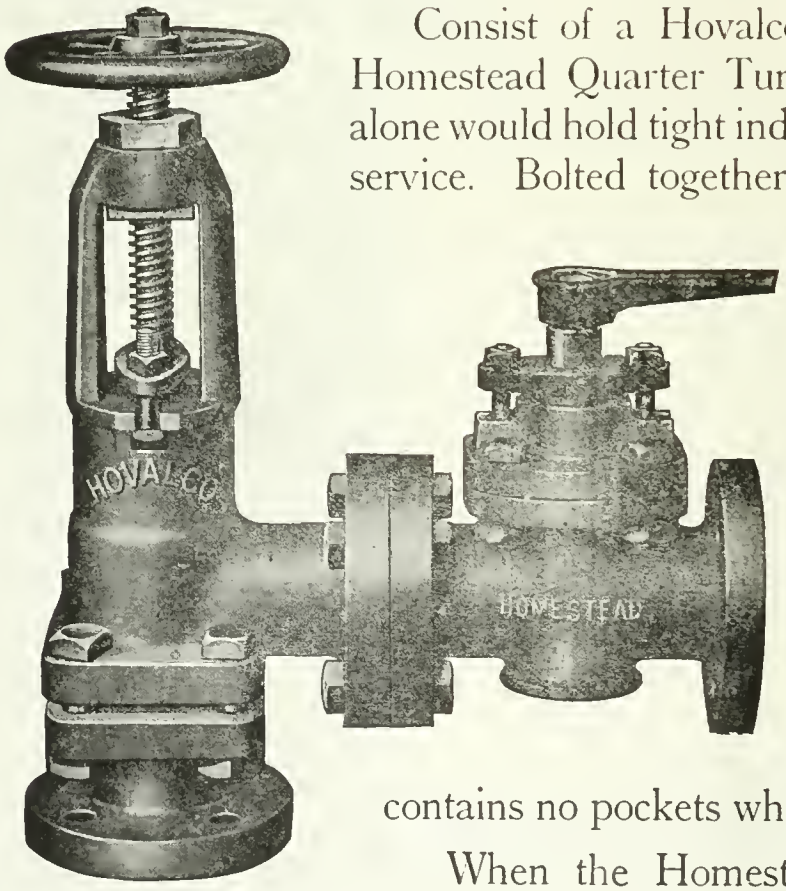
HOVALCO-HOMESTEAD

Combination Blow-Off Valves

Will Stop Those Leaks

They have stopped blow-off valve leakage in hundreds of plants.



Consist of a Hovalco Blow-Off Valve and a Homestead Quarter Turn Valve, either of which alone would hold tight indefinitely under the hardest service. Bolted together they are unbeatable for maintained tightness.

The Hovalco is provided with reversible special bronze seats and disc which may be also re-ground or renewed when worn. The removal of four bolts gives perfect access to both.

The clear passageway offers no obstructions and contains no pockets where scale may lodge.

When the Homestead Valve is closed the Hovalco Valve may be inspected and repaired without cutting the boiler out of service.

Order your requirements today.

Homestead Valve Mfg. Co.

134 6th Avenue, Homestead, Pa.

New York Office: 242 Lafayette Street, New York City.

A fire department you never heard of

HERE it is—posing for its picture. No clanging bells or shrieking sirens. No red lined coats. Nothing spectacular.

Just a few skilled workmen—yet these men save the ladder and the engine crews many a trip by making roofs fire-safe with Asbestos. For the time to put out fires is before they start. And there is no better way to prevent roof communicated fires than by covering roofs with Asbestos.

Moreover, it is not only through fire protection that Asbestos makes roofs safe, but also through weatherproof durability. In fact, Asbestos seems ordained by nature to be roofing material. This wonderful fibrous mineral is not only absolutely fire-proof, but in roofing form, it is immune to the disintegrating effects of sun, snow, hail, ice, rain, smoke and acid fumes.

On the big flat roofs of industrial plants and other buildings you will find Johns-Manville roofers applying permanent fire prevention with Johns-Manville Asbestos Roofing.*

And on thousands of smaller buildings the owners themselves, or their employees, are doing the same. For the many different types of Johns-Manville Asbestos Roofing give everyone the opportunity to protect what is ordinarily the most defenseless part of his building—the roof—with one of these roofings.

Asbestos Roll Roofing, Johns-Manville Standard and Colorblende Asbestos Shingles, Johns-Manville Asbestos Ready Roofing, Johns-Manville Corrugated Asbestos Roofing, Johns-Manville Built-Up Asbestos Roofings.

Johns-Manville Asbestos Roofings are approved by the Underwriters' Laboratories, Inc.

All Johns-Manville Asbestos Roofing is backed by Johns-Manville Service and Responsibility. Through our Roofing Registration Service we are able to keep in touch with Johns-Manville Roofing in Service. This is your assurance that it will give the service claimed for it.

JOHNS-MANVILLE COMPANY,
Madison Ave. at 41st St., New York City
10 Factories—Branches in 64 Large Cities
For Canada:
CANADIAN JOHNS-MANVILLE CO., Ltd.
Toronto

** In sixty-three cities throughout the United States and Canada there are Johns-Manville Branches, which have crews of expert roofers constantly employed in laying Johns-Manville Asbestos Roofing on large roof areas.*

And for the thousand and one types of modern buildings—including dwellings—Johns-Manville Asbestos Ready Roofings and Shingles are handled by dealers and dealer-contractors everywhere.

JOHNS-MANVILLE SERVICE
COVERS THE CONTINENT

Through—

Asbestos
and its allied products

INSULATION
that keeps the heat where it belongs
CEMENTS
that make boiler walls leak proof
ROOFINGS
that cut down fire risks
PACKINGS
that save power waste
LININGS
that make brakes safe
FIRE PREVENTION PRODUCTS

JOHNS-MANVILLE
Serves in Conservation

Co-operate:—Refer to The Blast Furnace and Steel Plant

Noheet METAL

¶CONFIDENCE is the best permanent foundation of business and the heart of all credit. No product has ever made good without it.

¶The people who manufacture and sell ***"Noheet"*** metal believe in it because they KNOW from its actual performances that it is the best bearing metal made. It has demonstrated its long-wearing qualities, its elimination of scored shafting and its economical service.

¶They know that ***"Noheet"*** die-cast bearings are without a peer.

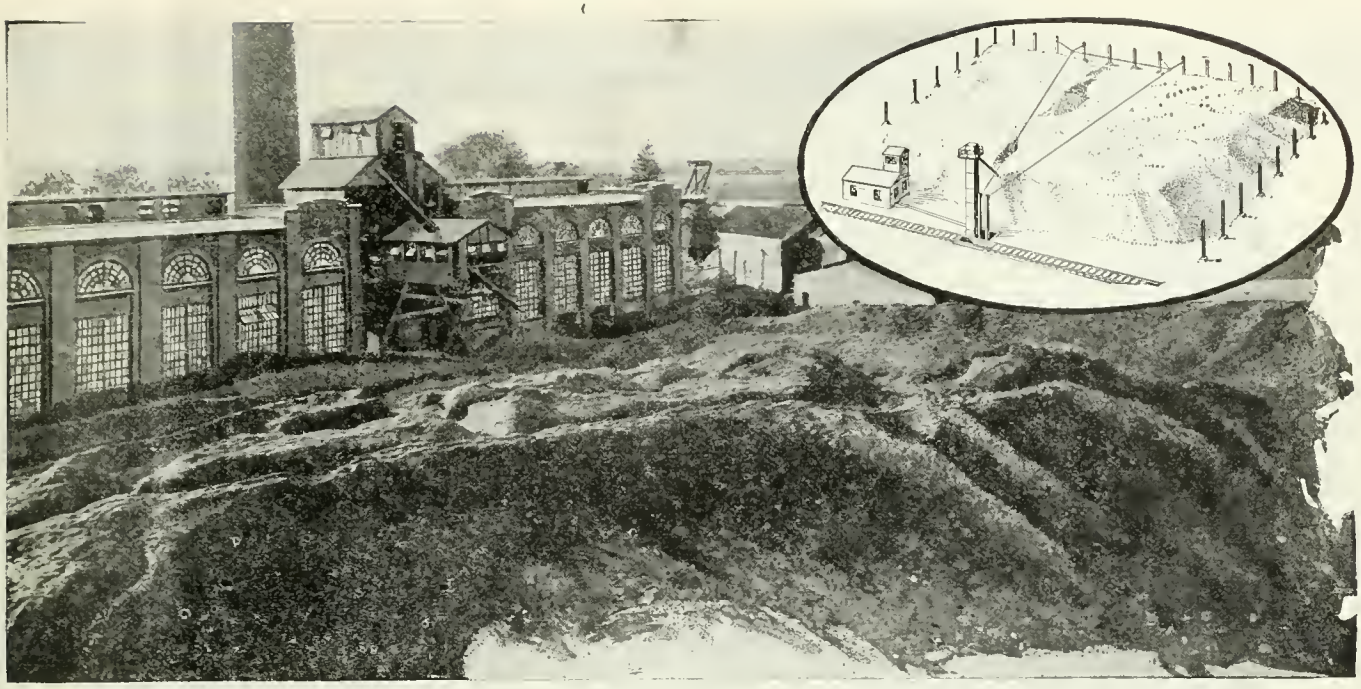
¶How about you? Do you want to save money?

The Lubricating Metal Co.

2 Rector Street, New York

Chicago Pittsburgh Cleveland

Noheet METAL



Storing Coal at a Labor Cost of Less Than 1c Per Ton

Beaumont
ONE CONTRACT
ONE RESPONSIBILITY

A Few Plants Using Beaumont Equipment

Wilmington & Phila. Traction Co. Wilmington, Del.
Alfred Wolstenholme & Sons Co. Philadelphia, Pa.
Philadelphia Suburban Gas & Elec. Co. Cromby, Pa.
United States Nitrate Plant No. 1 Sheffield, Ala. (2 contracts)
Monadnock Paper Mills Bennington, N. H. (2 contracts)
National Electrolytic Company Niagara Falls, N. Y.
Baldwin Locomotive Works Philadelphia, Pa.
Michelin Tire Co. Milltown, N. J. (2 contracts)

In determining the most efficient system of coal storage for your plant, give sufficient consideration to the labor element that enters into the operation of the storage system. A system that requires a licensed engineer or skilled operator is actually a liability, because such men are expensive and not readily replaced if they quit for one cause or another.

With a Beaumont Cable Drag Scraper System of coal storage, no skilled or licensed labor is necessary. Should the operator get sick or quit another man can step in and do the work without loss of time or money.

A Beaumont Cable Drag Scraper System is not only simple in operation but extremely economical in construction cost—no complicated machinery or expensive trestle work. Quickly installed or readily removed to a new location.

Look at the detailed sketch of the Beaumont Cable Drag Scraper System shown in the oval. Notice how the Drag Scraper hauls the coal out over the pile. 50 to 100 tons an hour can be stored at a labor cost of less than 1c a ton. The storage area may be any size or shape.

The coal is discharged into a hopper and elevated to a chute which piles it up. From there the Drag Scraper distributes it over the storage area. All the operating is done from the machinery house by *one* man. Any size coal is handled and the various sizes can be stored separately.

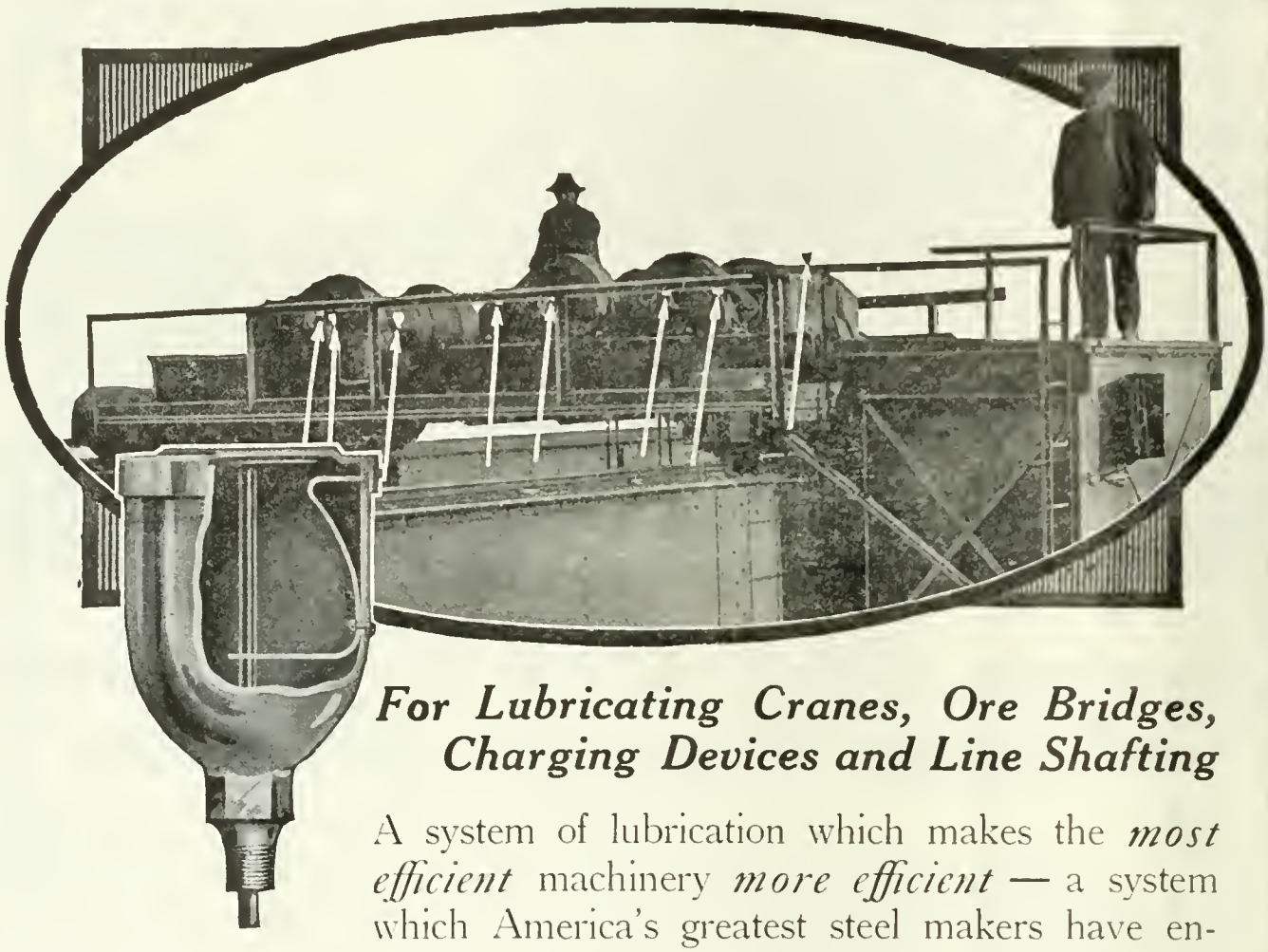
The advisability of buying coal during the slack season, and having it shipped in before the railroads get tied up with moving crops and severe weather, requires no argument. The Beaumont book "Cable Drag Scraper Systems for Storing Coal" gives further evidence of the wisdom of selecting this economical and dependable system. Send for it.

R·H· BEAUMONT CO·

Coal and Ash Handling Systems for Boiler Houses

330 Arch Street **Philadelphia**

Co-operate:—Refer to The Blast Furnace and Steel Plant



For Lubricating Cranes, Ore Bridges, Charging Devices and Line Shafting

A system of lubrication which makes the *most efficient* machinery *more efficient* — a system which America's greatest steel makers have endorsed for use on the most important steel plant units.

The Keystone Venango Gravity Grease System

is famous for its efficiency, economy and ease of operation, at *all* times under the severest working conditions. Many of the largest cranes in the world now Keystone-equipped, are rendering better service than ever before. Why not arrange for a trial installation at our risk and expense.

The Keystone Lubricating Company

New York
Boston
Pittsburgh
Chicago

Executive Office and Works
PHILADELPHIA, PA.
Established 1884

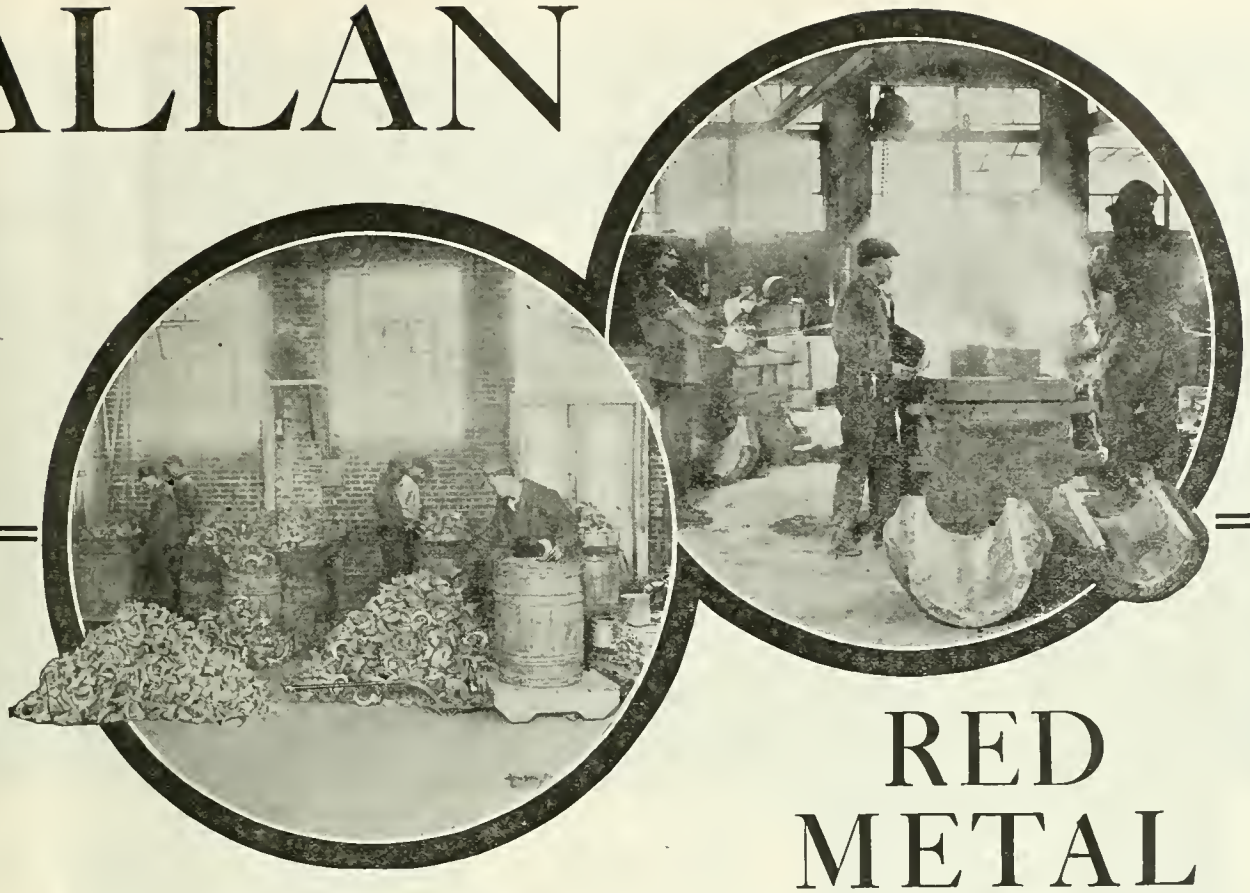
Denver
St. Louis
San Francisco
Minneapolis
Houston

Continental European Offices, Marseilles, France

KEYSTONE
TRADE MARK
Reg. U.S. Pat. Off.
GREASE

Co-operate:—Refer to The Blast Furnace and Steel Plant

ALLAN



RED METAL

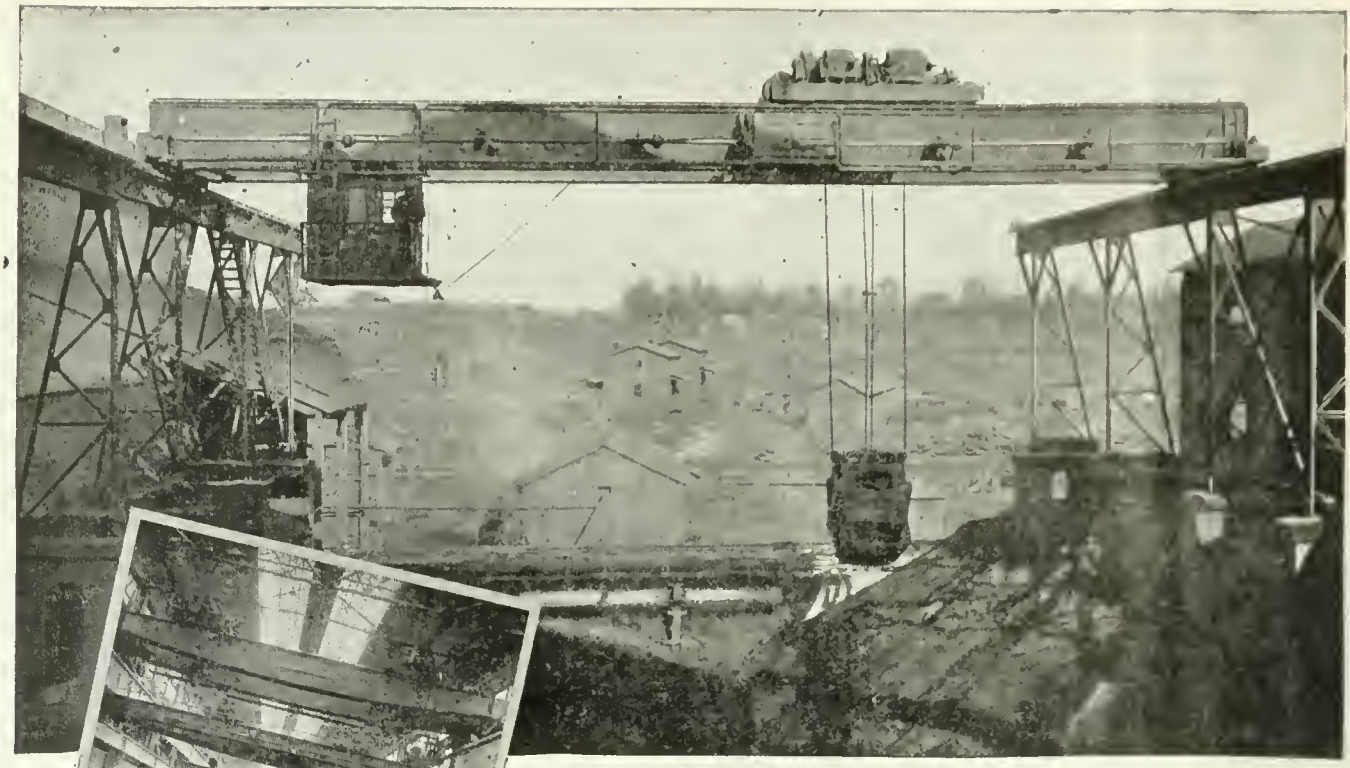
THE Genuine Lead-Copper anti-friction metal. The anti-friction metal that will give efficient service at temperatures that would destroy any tin base babbitt metal. The anti-friction that will not stick to, cut or tear the pin or rod, even under the most severe service conditions.

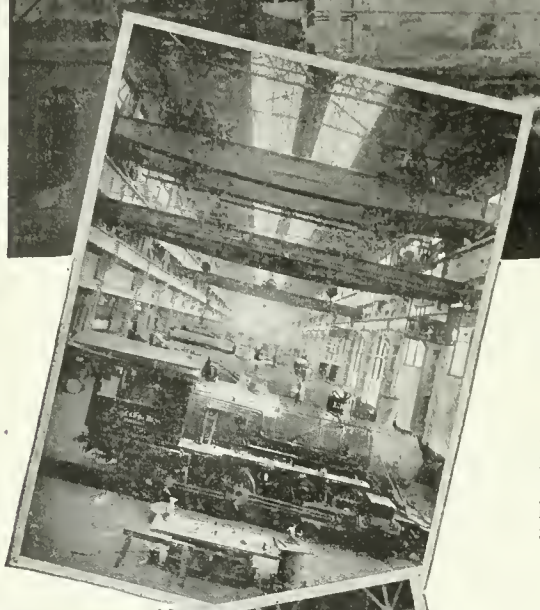
For over a quarter of a century we have been giving publicity to the above trade-mark. This continued publicity is only possible by the true service merits of the alloy it represents. Merits which turn trial orders into repeat orders. Merits which have placed on our ledger active accounts with most of the large steel mills. Merits that have sold millions of pounds of Allan Red Metal to be used for facing both H. & L. pressure pistons, packing for piston rod and valve stems for superheated steam service, mill, turbine, crank tin, cross head, motor and high speed bearings.

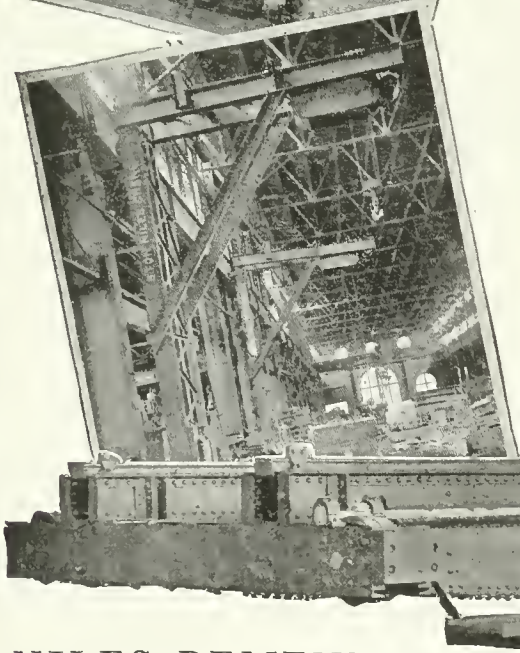
Sole manufacturers of Allan Red Metal, Allan Bearing Bronze.
Correspondence solicited. May we send you literature?

A. ALLAN & SON

HARRISON, N. J.







Electric Traveling Cranes

For Inside and Outside Service

Niles Cranes fill all the requirements of modern crane service. Whether for use inside the shop conveying castings or machine parts, or outside handling raw materials to ground storage there is a type or capacity to just suit your needs.

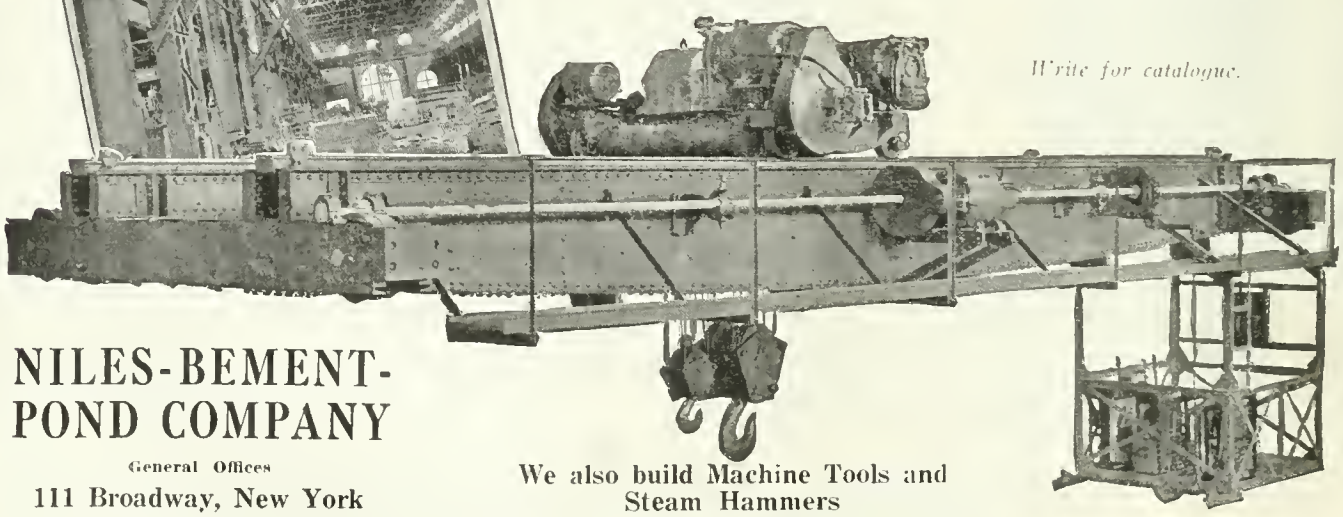
BUILT IN SIZES FROM TWO TO TWO HUNDRED TONS

Niles Cranes have an exceptionally wide application in steel mills, foundries and industrial plants of all kinds.

They are potent factors in speeding up and lightening work. Quietness, safety, efficiency in operating and an unusual freedom from maintenance and repair expense are desirable features that distinguish Niles Cranes.

We also build Gantry Cranes, Gib Cranes, Wall Cranes, Monorail Grab Bucket Hoists and Trolleys.

Write for catalogue.



NILES-BEMENT-POND COMPANY

General Offices

111 Broadway, New York

We also build Machine Tools and Steam Hammers

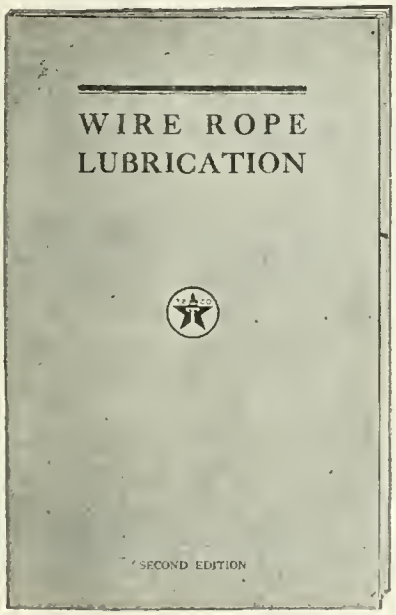
47

Co-operate:—Refer to The Blast Furnace and Steel Plant

If you are using wire rope and want to save money—

Our Book
WIRE ROPE LUBRICATION
tells you how

It's Free



Every user of wire rope and heavy machinery should read this book.

IT TELLS how to get longer, better service from your wire ropes and cables. It explains how to give them proper care and correct lubrication.

It describes Texaco Crater Compound No. 1, the great wire rope lubricant and protector. It is adhesive and waterproof. It does not sling or drip and in that way go to waste. It saves money on lubrication.

Then, too—Crater does not merely coat the outside of the rope but penetrates to the core and coats all the inner wires with a film of rich heavy lubricant.

The book tells how this works to *save* ropes—it also contains items of interest to other users of heavy machinery.

Here's the Coupon that brings it

THE TEXAS COMPANY

Dept. BL, 17 Battery Place, New York City

Offices in Principal Cities

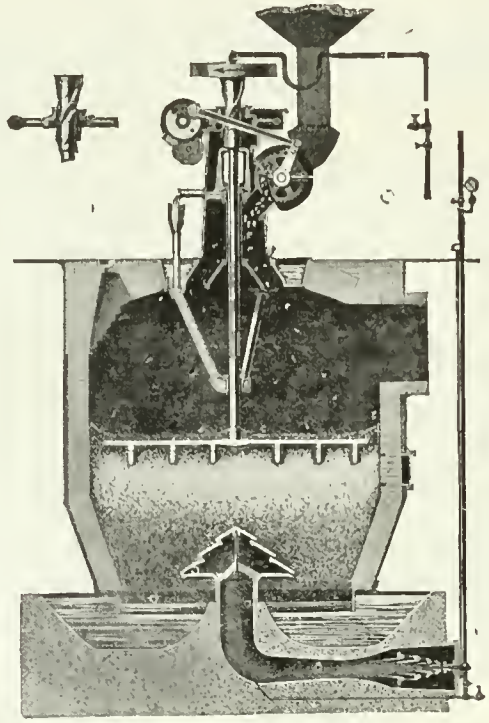
Kindly send me Free, your "Wire Rope Lubrication" Book.

.....

.....

.....

920



WANTED:

A Man

To Operate Hand Poked Gas Producers

There Were No Replies To The Above Advertisement

This is not unusual when you remember that there are more jobs today than there are men to fill them. This makes it impossible to keep an intelligent man on the old hand poked gas producer floor. There are easier jobs elsewhere. Places to work where one doesn't have to handle a 70 pound poker in an atmosphere of nauseating producer gas with a white hot flame scorching your face.

But even before the labor situation made it impossible to keep men on the hand poked producers, The Chapman Engineering Company was developing the producer which was to revolutionize gas house conditions. Should you visit many of our plants today you would not see a man on the producer floor for hours at a time. Yet the same uniform supply of gas keeps coming over to the tanks allowing only a few degrees temperature variation as shown on the pyrometer record.

These are only some of the reasons why our customers so frequently report a saving of 100% on the investment during the first year of operation then send in the second, third and fourth repeat orders for additional equipment.

Talk your fuel situation over with one of our engineers.

The Chapman Engineering Co.

Mt. Vernon, Ohio

11 Broadway, New York — Oliver Bldg., Pittsburgh

Co-operate:—Refer to The Blast Furnace and Steel Plant

GULF LUBRICANT
—for—
GEARS AND CABLES

A scientifically prepared lubricant to meet every condition found in Steel Mill practice.

Gears—Hydraulic Plungers—Chains
Main Drive Pinions — Cable Hoists
Bevel Table Gears, etc.

Allow our engineers to make a survey of your plant and be assured of perfect gear lubrication.

GULF REFINING COMPANY

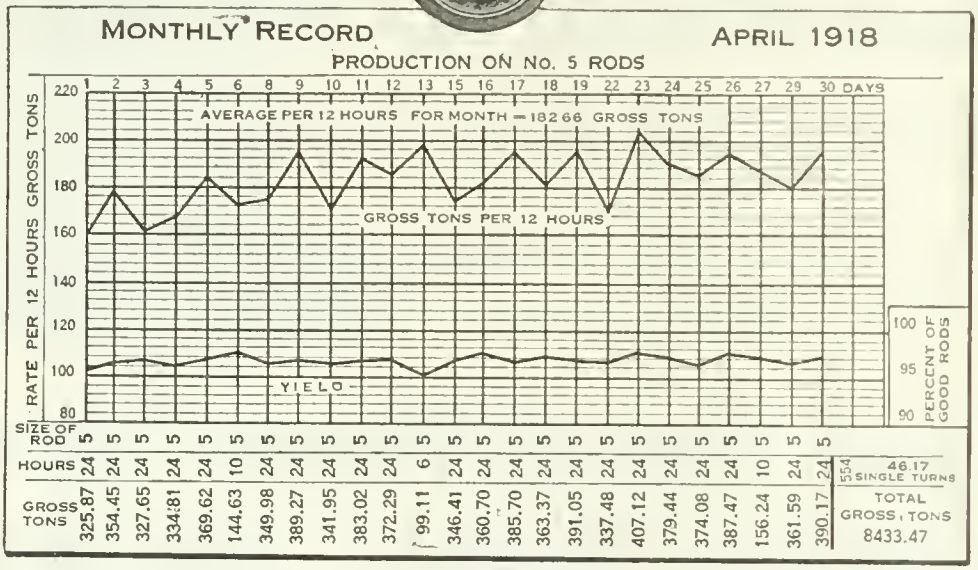
General Sales Offices, PITTSBURGH, PA.

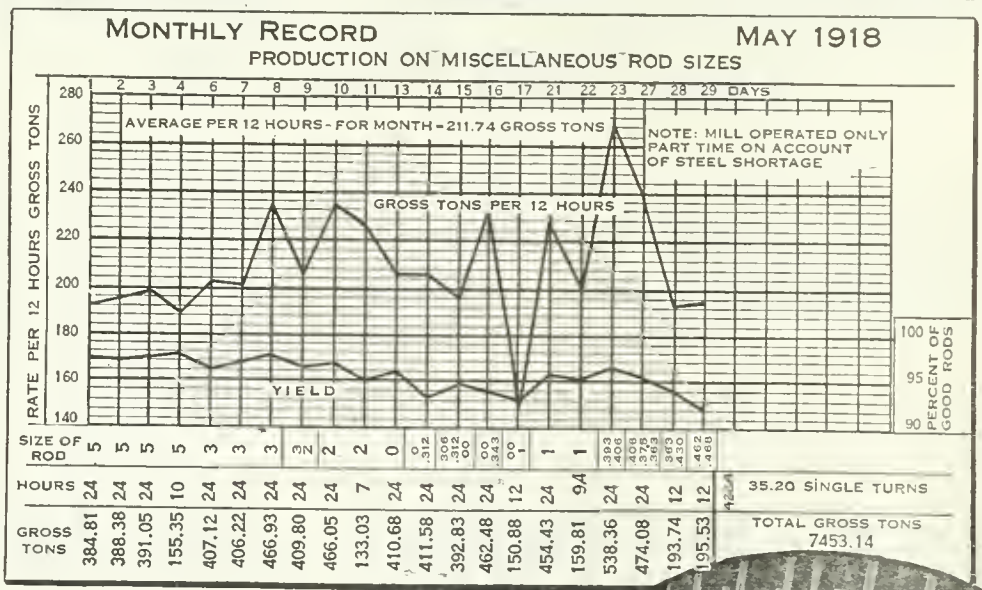
District Sales Offices:

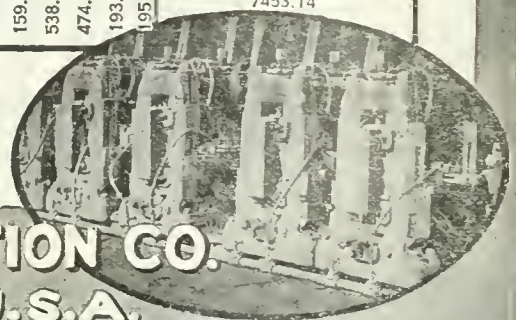
New York	Philadelphia	Boston
Atlanta	New Orleans	Houston

MORGAN
OF WORCESTER
CONTINUOUS DOUBLE STRAND
ROD MILLS

M C Co





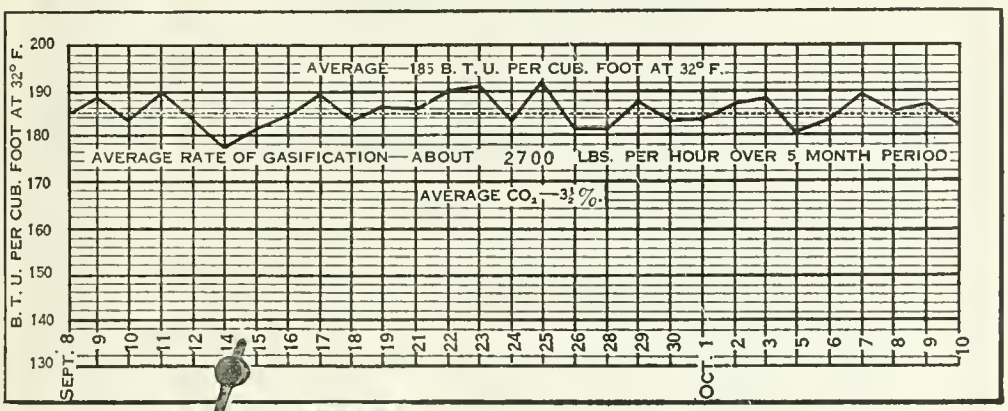


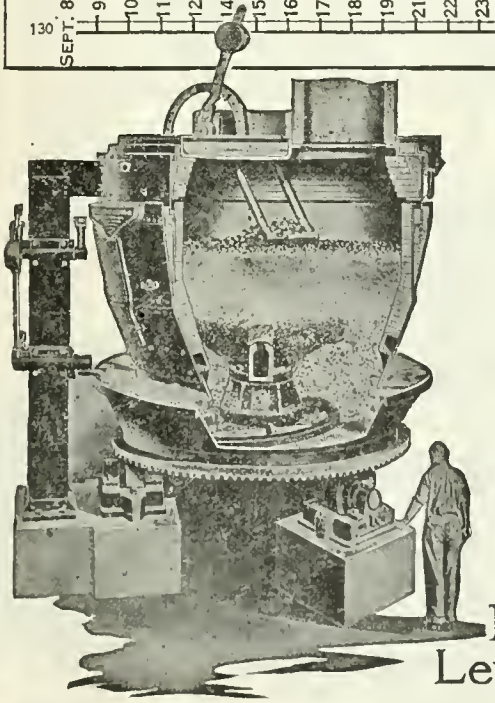
MORGAN CONSTRUCTION CO.
WORCESTER, MASS., U.S.A.

MORGAN
OF WORCESTER
PRODUCER GAS MACHINE

M C Co

Eight-hour Continuous Gas Samples from records of work's chemist at one of the well known Steel Plants in the U.S.A.


B. T. U. PER CUB. FOOT AT 32° F.
200
190
180
170
160
150
140
130
AVERAGE—185 B. T. U. PER CUB. FOOT AT 32° F.
AVERAGE RATE OF GASIFICATION—ABOUT 2700 LBS. PER HOUR OVER 5 MONTH PERIOD
AVERAGE CO_2—3½%.
SEPT. 8 9 10 11 12 14 15 16 17 18 19 21 22 23 24 25 26 28 29 30 OCT. 1 2 3 5 6 7 8 9 10



MORGAN PRODUCER GAS MACHINES maintain the quality of gas continuously at a high value . . . the operation is not dependent upon the human element .

Continuous Mechanical Feeding, Levelling and Ash Discharge

MORGAN CONSTRUCTION CO.
WORCESTER, MASS., U.S.A.

MORGAN
ROLLER STRAIGHTENERS
FOR MERCHANT AND STRUCTURAL MILLS

M C Co

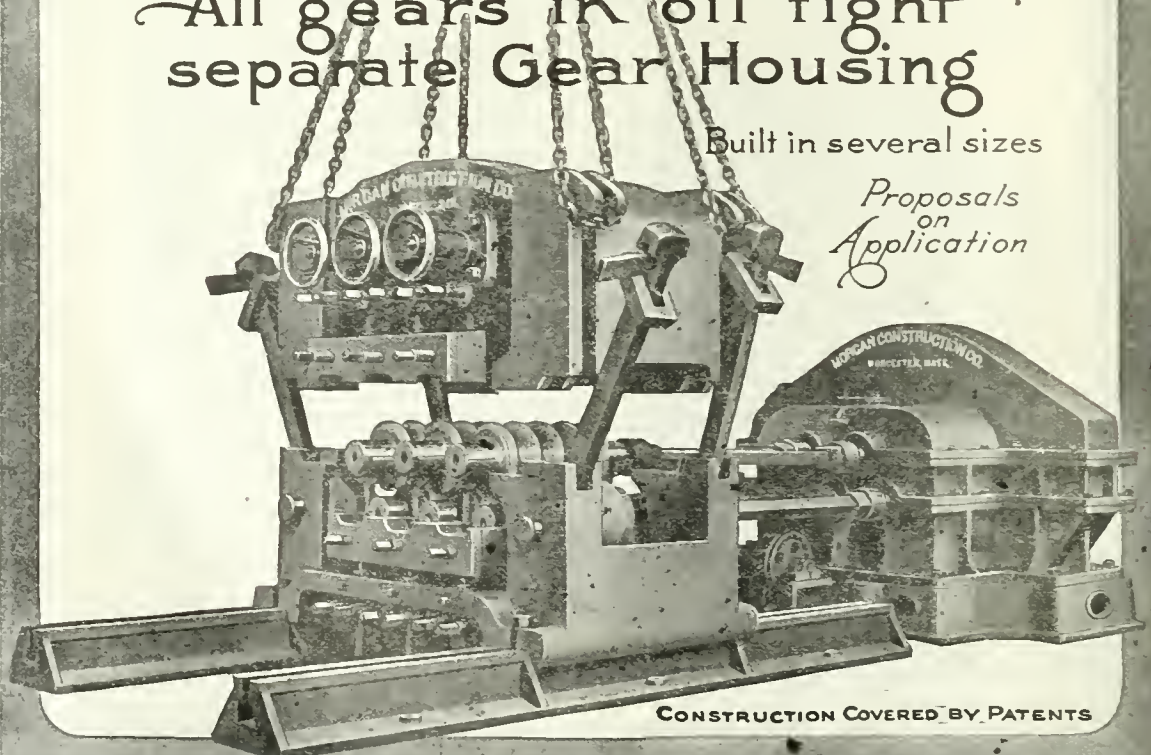
TIME SAVING
All rolls can be changed in
. 20 minutes .

CONVENIENCE
All roll adjustments from
. the front .

CONSTRUCTION
All gears in oil tight
separate Gear Housing

Built in several sizes

Proposals on Application



CONSTRUCTION COVERED BY PATENTS

MORGAN CONSTRUCTION CO.
WORCESTER, MASS. U.S.A.

Contentment must come to the *highly efficient;* as, having excelled, they should be at peace with their tools and their fellow men.

—*Wilderness Philosophy.*

IN that vast laboratory of experience, the mill, the real proving ground of the merits of an invention, Adamite has been put to every conceivable test.

That it has made more than good is the verdict of the most up-to-date operators in the most efficient and largest tonnage mills in the country.

To these operators—the acknowledged leaders in the iron and steel industry—Adamite has come to be recognized as the standard alloy on which all heavy duty performance is based.

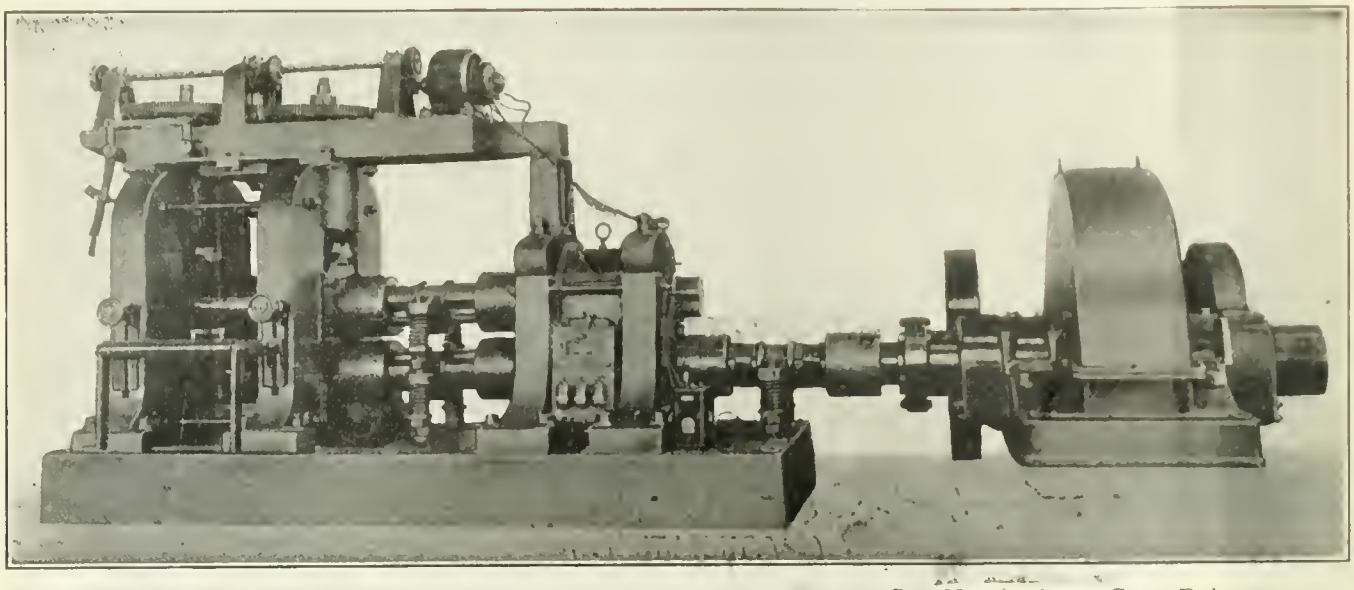
What Adamite is doing for others it can do for you. You can safely follow the lead of these men—their judgement is sound and based on mature investigation.

Pittsburgh Iron & Steel Foundries Co.

Executive Offices, PITTSBURGH Foundries, MIDLAND, PA.

United Engineering & Foundry Co., Pittsburgh, Sole Licensees

Co-operate:—Refer to The Blast Furnace and Steel Plant



Motor Driven Strip Finishing Mill with Motor Screwdown and Cut Herringbone Gear Drive.

CHILLED, SAND AND STEEL ROLLS

Rolling Mill Machinery—All Types of Shears—Roll Lathes

LEWIS FOUNDRY & MACHINE COMPANY

PITTSBURGH, PA.

Works
Groveton, Pa., on the
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Office
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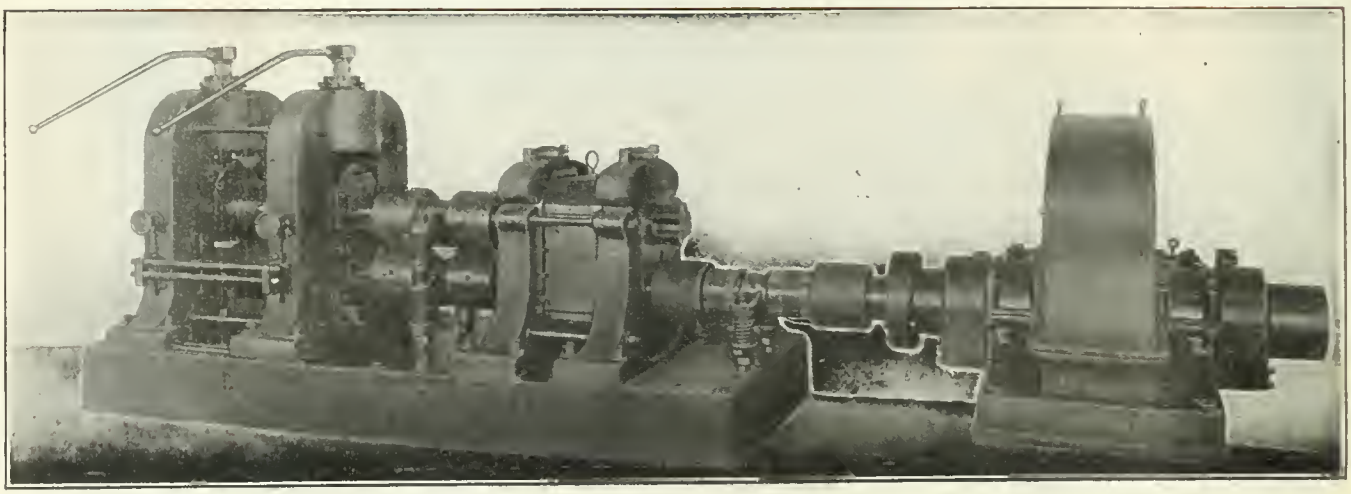
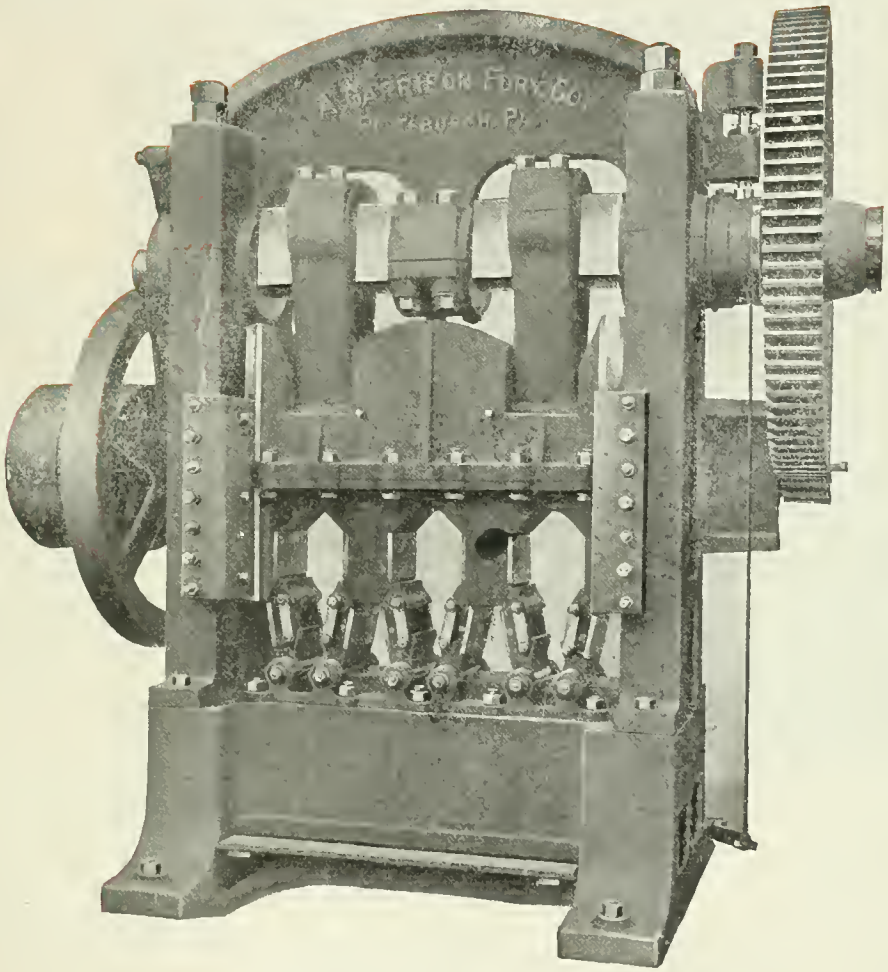


Motor Driven Strip Roughing Mill with Cut Herringbone Gear Drive.

Co-operate:—Refer to The Blast Furnace and Steel Plant

Forging Presses



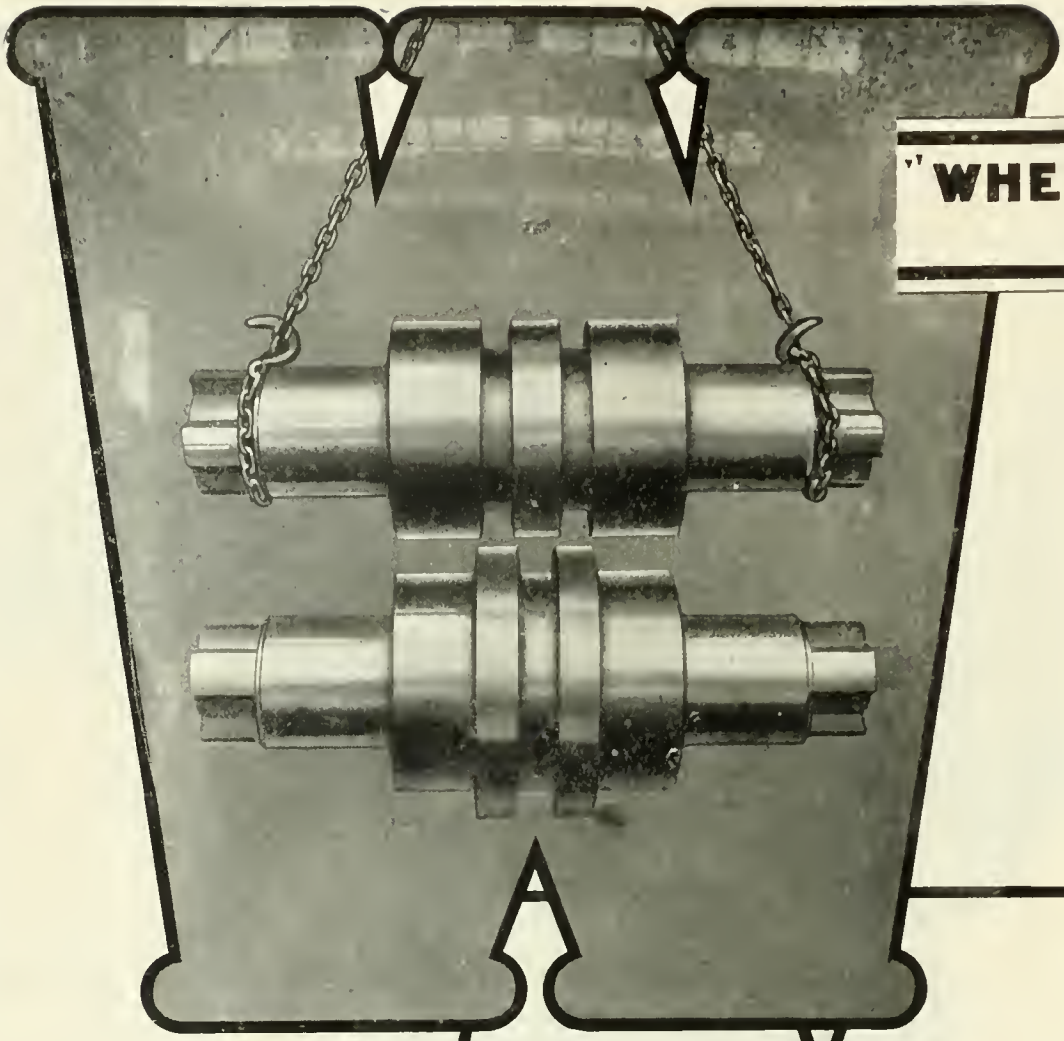
PICKEYE PRESS
embodying many special features

A. GARRISON FOUNDRY CO.

BINGHAM STREET, PITTSBURGH, PA.

Builders of

Complete Machinery Equipment for Iron, Steel, Tube, Zinc, Brass, and Aluminum Works---Forging Presses, Sand and Chilled Rolls



"WHEELING" QUALITY

Chilled Rolls
Sand Rolls
Steel Rolls
and Super-Steel Rolls.

Iron Castings
Steel Castings
Rolling Mill and Special Machinery.

YEARS of experience in the making of high grade rolls, and the added advantages that a modern plant affords enables us to guarantee a lasting satisfaction in the use of "Wheeling Quality" products.

We will gladly quote on your specifications.

WHEELING MOLD & FOUNDRY CO.
WHEELING W. VA.

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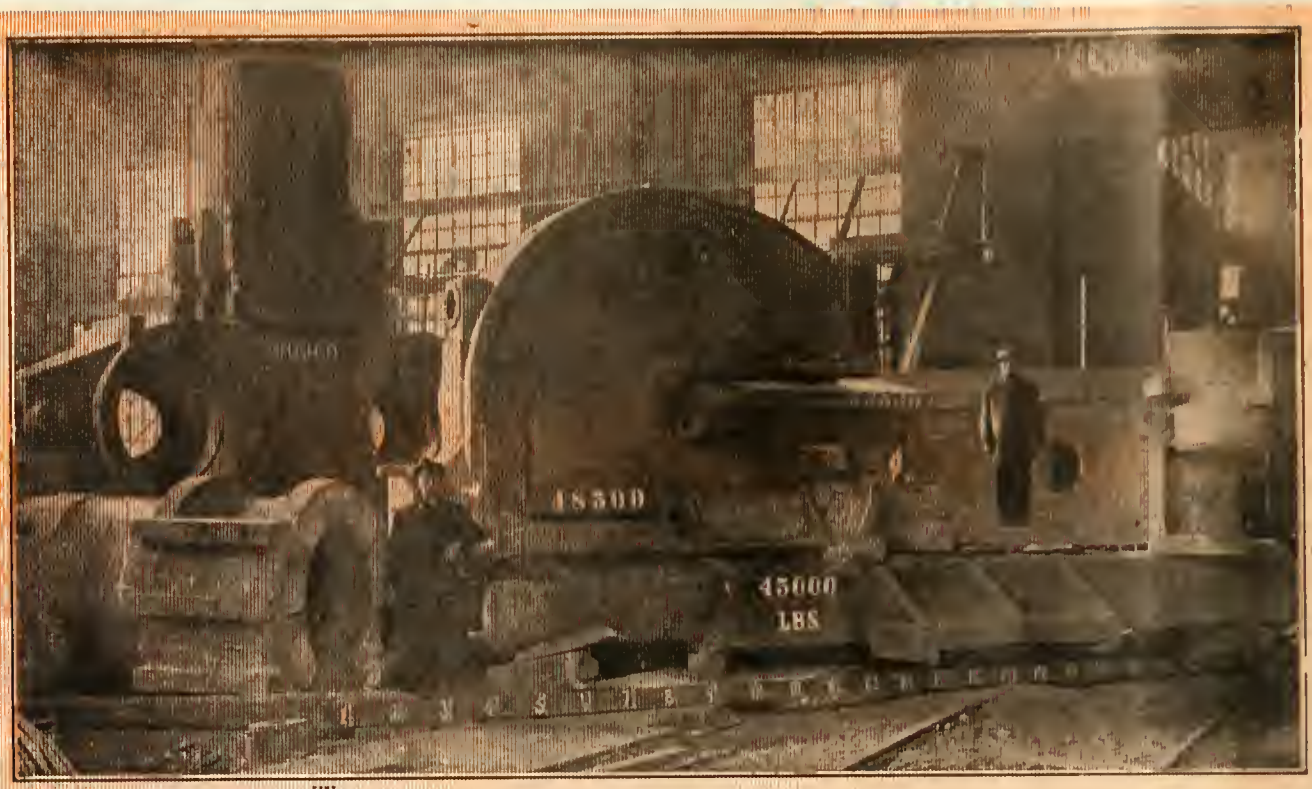
ROLLING MILL STEEL CASTINGS

American Steel Foundries
Chicago Pittsburgh



BIRDSBORO
STEEL CASTINGS
IRON CASTINGS--INGOT MOLDS

Iron Chilled and Sand --ROLLS-- Alloy and Carbon Steel
Durite (patented)

Blast Furnace Machinery, Rolls, Rolling Mill Machinery, General or Special Machinery, Buchanan Crushers and Concentrating Machinery, Chilled Iron Pump Plungers, Roll Lathes, Jackson Belt Lacing Machines.

Hydraulic Presses and Accumulators

Birdsboro Steel Foundry & Machine Co.,

Birdsboro, Pennsylvania

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MESTA-ROLLS

CHILLED and SAND CAST IRON ROLLS

CARBON STEEL and ALLOY STEEL ROLLS

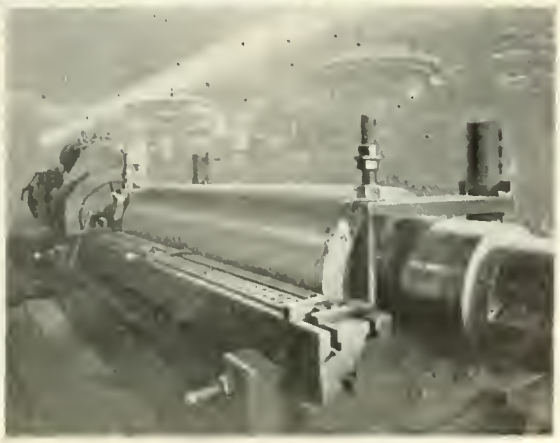
MESTA SPECIAL ROLLS

An extremely hard but strong roll of Chrome-Nickel composition, specially heat-treated.

View in Roll Turning Department equipped with 27 Lathes

View in Roll Shipping Department

View below shows 44" x 100" Chilled Roll in Finishing Lathe



CARBON STEEL and ALLOY STEEL PINIONS

With Cut or Machine Molded Teeth.

MESTA MACHINE COMPANY

PITTSBURGH PENNSYLVANIA

Manufacturers of

Large Gas and Steam Engines, Rolling Mill Machinery, Gear Drives, Pickling Machines, etc.

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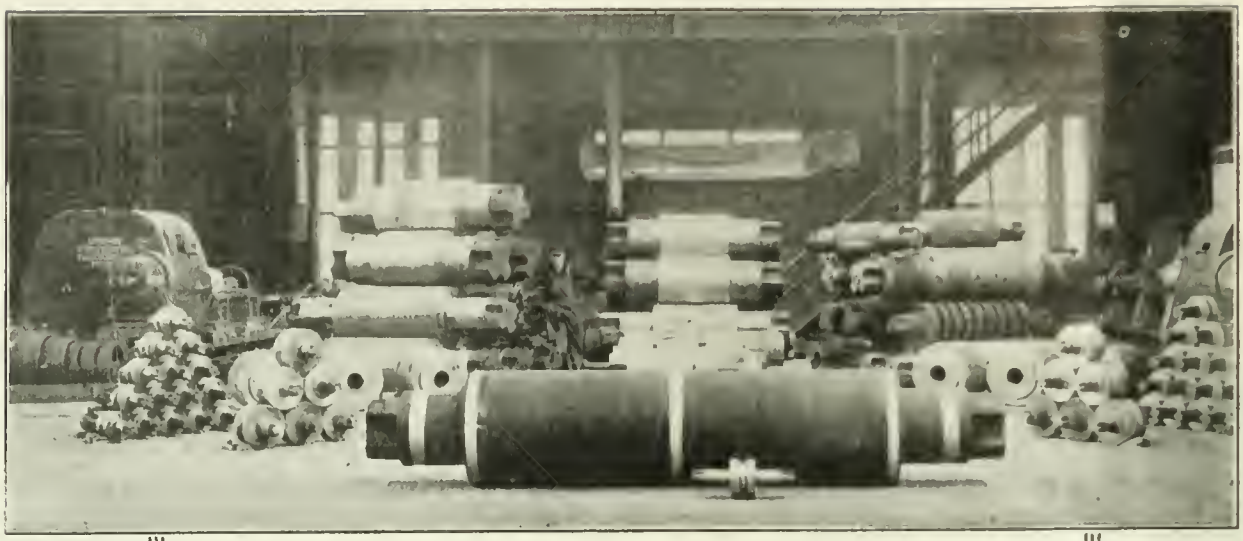


SAND AND CHILLED

ROLLS

ROLLING MILLS
SEAMLESS TUBE MACHINERY
PIPE MILL MACHINERY
PIPE THREADING MACHINERY

ROLL LATHES

STANDARD ENGINEERING CO.

Designers and Manufacturers

ELWOOD CITY, PENNA. U. S. A.

PITTSBURGH OFFICE—GRANITE BLDG.

Co-operate!—Refer to The Blast Furnace and Steel Plant

Comfort Stimulates Production

The source of the largest production will usually be traced to the operator being able to concentrate his entire attention to the production of the article in question.

Distraction and inattention naturally hinder the operator from performing his best work which, of course means a loss to the employer.

The Baird Water-Cooled Standings minimize to a large degree the heat at mill stands, therefore making the surroundings comfortable for the men whose attention is not distracted by the heat.

The success of the installations have proven their value.

Complete data on request.

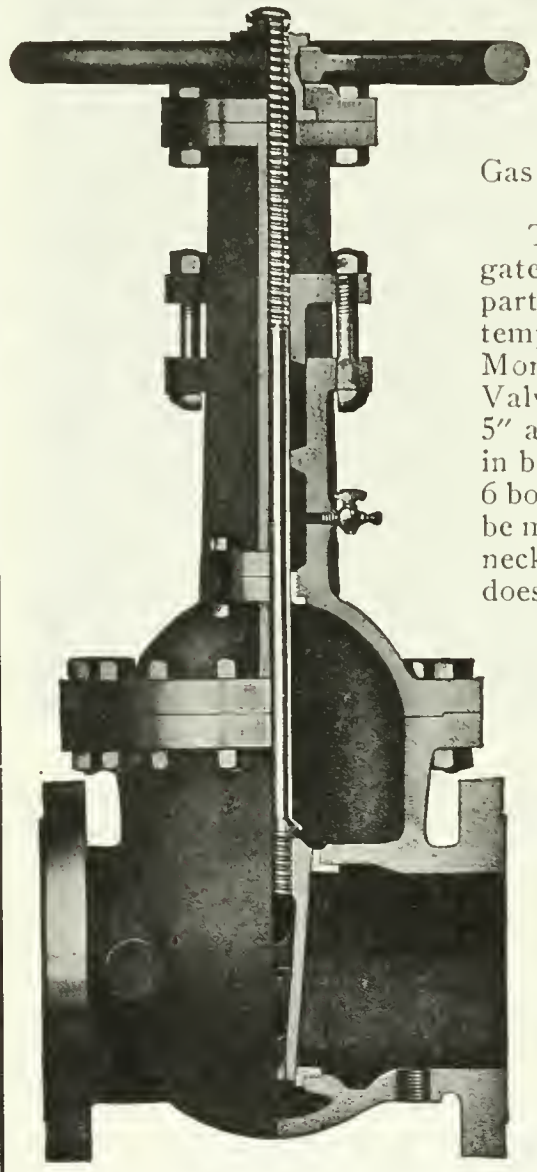
Makers of Sand Chilled and Cast Steel Rolls, Mill Pinions, Rolling and Finishing Mill Machinery, Heavy Air Furnace Castings from Gray Iron, Charcoal and Semi-Steel.

The National Roll & Foundry Co.

AVONMORE, PENNA.

Specialists in Rolling Mill Requirements

CHAPMAN VALVES



Comprise a complete line in many types and sizes to meet the diversity of valve uses, including Gate Valves for superheated steam, Turbine Exhaust Valves, Water Valves, Blow-Off Valves, Gas Valves, Check Valves, Sluice Gates, etc.

This shows a section of list 63½ Wedge type steel gate valve for superheated steam, internal working parts; 350 pounds working pressure; 800 degrees total temperature. Body and cap of cast steel; spindle rolled Monel, Spindle Seats and Seat Rings cast Monel. Valves up to 4½" size, inclusive, have solid Monel plugs, 5" and above, cast steel plugs with Monel faces, rolled in by special process and guaranteed not to work loose. 6 bosses are cast on each valve body so that tapping can be made in any desired position. Caps are made of long neck type allowing for radiations so that intense heat does not reach packing, thus lengthening its life.

A Few Blast Furnace Plants Where Chapman Valves Have Been Installed:

Allan Wood Iron & Steel Co.
American Iron & Steel Co.
Bethlehem Steel Co.
Carpenter Steel Co.
Dominion Iron & Steel Co.
Ford Motor Co.
Lukens Iron & Steel Co.
Midvale Steel Co.
Minneapolis Steel Co.
Republic Iron & Steel Co.
Steel & Tube Co. of America
United Alloy Steel Corporation
Youngstown Sheet & Tube Co.

Iron Body Gate Valve

For water, steam, air or gas furnished with bronze or iron mountings, single or double discs, inside or outside screw. Designed for minimum space. An excellent valve on pump suction lines, exhaust and condenser piping in steam power plants and by-product coke plants.

Each Chapman Valve is designed to best serve its particular purpose. Likewise, each component part is made of that particular metal which long years of experience in building only valves has proven most efficient.

Doing the same thing day after day, holding fast to the ideals of the past and constantly striving to attain a higher standard account for our leadership.

The WEBSTER OF VALVES, our No. 38 Reference Book containing invaluable data on all types of Valves for every purpose, will be gladly sent on request.

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASS.

Branches and Agents With Stock: Boston, Chicago, New York, Pittsburgh, Philadelphia, San Francisco.

This Book is for YOU

It describes an engineering achievement which has contributed substantially to the efficiency of water-tube boilers. It is therefore of real interest to every executive—every engineer or plant superintendent—who seeks higher operating standards and lower costs. Your copy will be sent on request.

How Boiler Troubles Are Being Remedied

Several years ago a new way to baffle boilers was devised. It was an interesting idea from the first, and became more interesting and more important as it was developed.

Directly or indirectly by means of this method of baffling, it has been possible to remedy, in one instance or another, practically every conceivable trouble and difficulty with water-tube boilers.

As a result, the total horsepower of boilers equipped with Turner Baffle Walls is now in the millions. The records of operating improvements and lowered costs are interesting reading—in some cases almost unbelievable.

Write for the Book

It tells the general story of Turner Baffle Walls, cites many specific instances and will suggest the possibility of improvements and economies in your own boilers. A new edition has lately come from the press; write for your copy now.

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Builders' Exch. Bldg.
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Coristine Bldg.
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Turner Baffle Walls
Produced exclusively by The Engineer Company

Balanced Draft
Produced exclusively by The Engineer Company

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Keystone Quality

BRONZE AND COPPER CASTINGS

easily pass where the inspection is most rigid

Hot and Cold Mill Bearings for Sheet and Tin Mills.
Blast Furnace Copper and Bronze Tuyeres, Coolers,
Bosh and Stack Plates, Hot Blast Valve Seats, etc.
Railroad Car Journal Bearings and Engine Castings.
Acid Resisting Bronze.
Keystone Special High Tensile Metals.
Bronze and Copper Castings for any purpose.
5, 10 and 15% Phosphor-Copper.

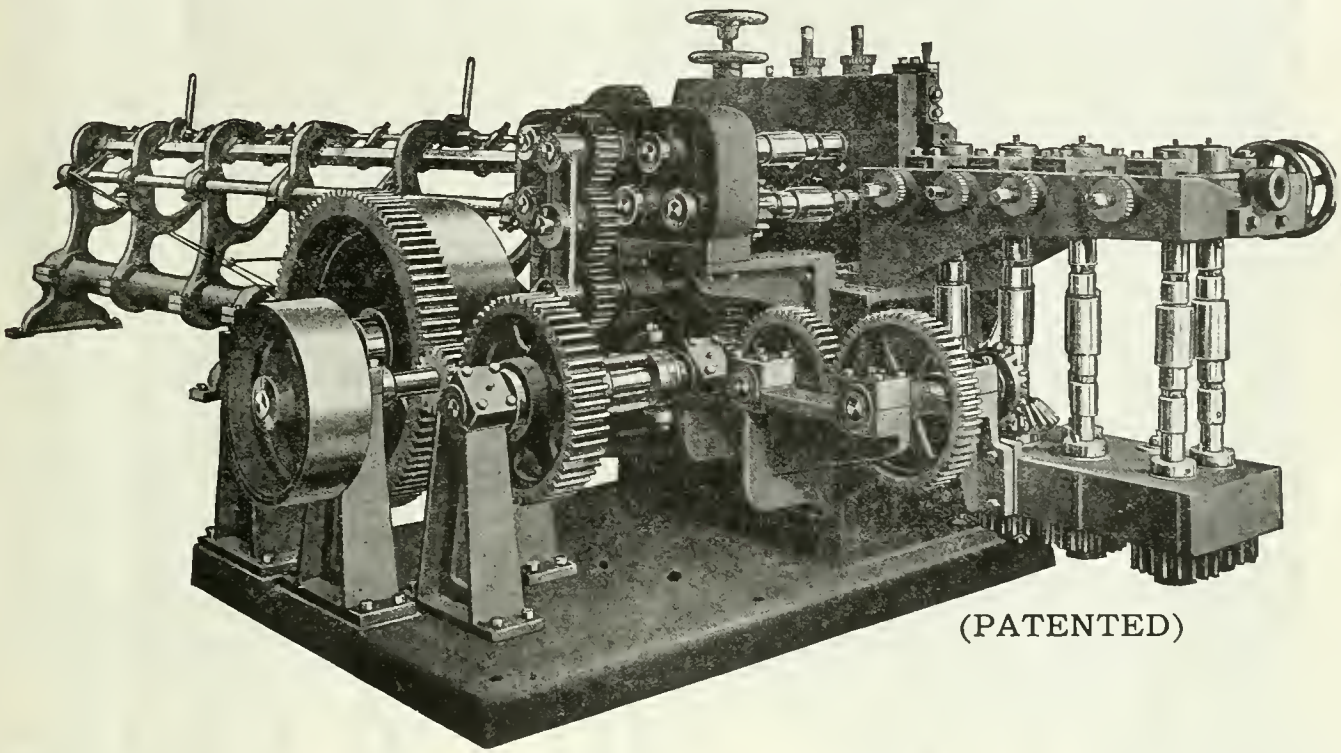
Send us your specifications.

KEYSTONE BRONZE CO.

TWO MODERN PLANTS

General Offices: 39th St. and A. V. R. R., Pittsburgh, Pa.
Keystone Plant - - - - - Pittsburgh, Pa.
American Plant - - - - Pittsburgh, Pa.

SHAPE STRAIGHTENER AND CUTTER



(PATENTED)

Handles Square, Hexagon and Flat stock.

Takes it **from the coil,** straightens two ways, and cuts to accurate lengths. Steel, brass, aluminum, all kinds of special alloys, etc., handled with equal facility.

The universal joints on the roll and roll gear shafts give independent adjustment to the rolls permitting several sizes of one shape to be handled with one set of rolls. A patented clutch mechanism stops the feed while the cutting is done.

Belt or motor drive, as required.

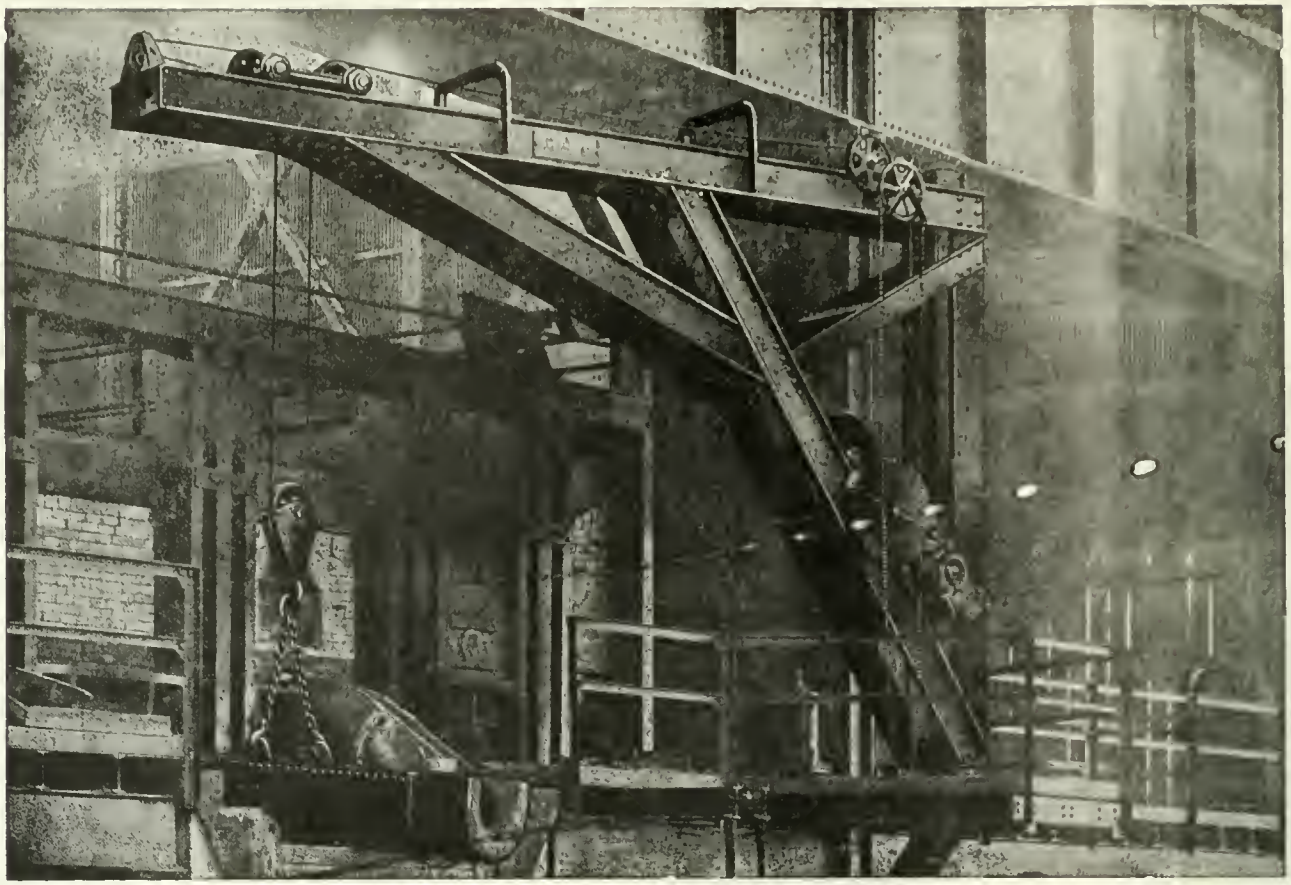
Glad to furnish further information and Catalogue on request.

THE F. B. SHUSTER CO.

NEW HAVEN, CONN.

formerly John Adt & Son Established 1866

Also makers of Straighteners and Cutters for rounds, etc.



WHITING JIB CRANES

For Handling Open-Hearth Furnace Spouts

Some of Our Users.

Carnegie Steel Company	55
Indiana Steel Company	28
Republic Iron & Steel Co.	15
River Furnace Company	12
Forged Steel Wheel Company	11
National Tube Company	10
Brier Hill Steel Company	10
United Steel Company	10
Inland Steel Company	9
Lackawanna Steel Company	8
Colonial Steel Company	3
Steel Company of Canada	3

Of all-steel construction, rigidly braced. Motor is provided for hoisting while trolley is racked by hand. All gears are cast steel, pinions forged steel, all cut from solid. Entire hoisting gearing is enclosed, and equipped with bronze bushings.

Specifications gladly furnished on request.

Send for Crane Catalog No. 151.

WHITING

CRANES OF ALL TYPES / FOUNDRIES EQUIPPED COMPLETE

Harvey (Chicago Suburb) Ill.

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THE IRONSIDES COMPANY
COLUMBUS OHIO

Ironsides Gear Shield

Ironsides Wire Rope Shield

Ironsides Automobile Gear Shield

Your Wire Ropes and Gears—protect them from rust and deterioration—Ironsides lubricants mean fewer replacements.

Ironsides Wire Rope Shield—for preservation and lubrication—widely used in Mines, Blast Furnaces, Steel Plants and Factories.

Ironsides Gear Shield—lessens noise, wear and costly replacements—used by up-to-date Rolling Mills.

Ironsides Cold Neck Shield—the best roll-neck lubricant in existence—for Rolling Mills.

Ironsides Cold Neck Shield

Wrought iron pipe *versus* "Wrought pipe"

¶"Wrought pipe" is an indefinite term.

¶Wrought iron pipe is a very definite term, designating the product of the puddling furnace, and is a high-priced quality product.

¶Steel pipe is a very definite term, designating the product of the bessemer or Open Hearth process and is a low-priced quantity product.

¶Consequently there is no justification for the use of the term "wrought pipe". Its use puts a manufacturer or dealer under the suspicion of purposely attempting to confuse the trade.

¶Send for your copy of Bulletin No. 1: *Reading Wrought Iron Pipe in the Making and in Service,* and be convinced that wrought iron is better than steel.

Specify Reading—the Pipe that Endures

READING IRON COMPANY, Reading, Pennsylvania

New York
Philadelphia
Boston
Pittsburgh

READING
WROUGHT IRON PIPE

Chicago
Cincinnati
Houston
Los Angeles

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The Automatic Gas Producer

Has the Following Features—

AUTOMATIC FEEDING THE COAL

AUTOMATIC ASH DISCHARGE

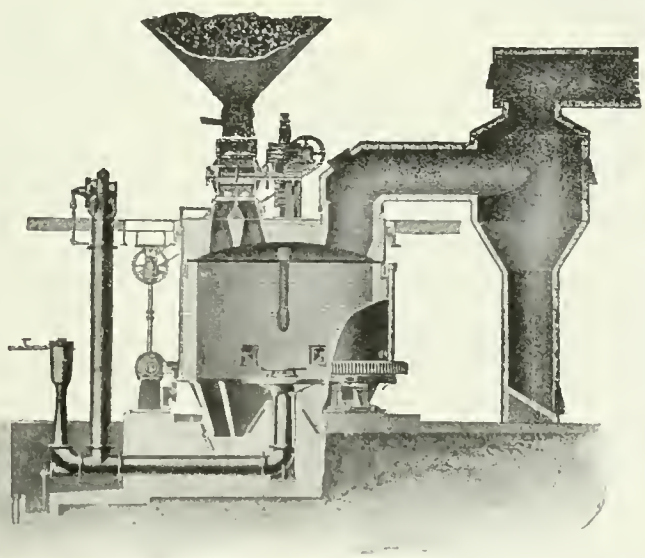
AUTOMATIC AGITATION OF THE FUEL BED

ARCHED FIRE BRICK TOP

TURBO FAN BLOWER EQUIPMENT

WORM DRIVE OF SHELL AND BARS

Gasifies 50 tons of coal in 24 hours.



If interested write for pamphlet.

R. D. WOOD & COMPANY

PHILADELPHIA, U. S. A.

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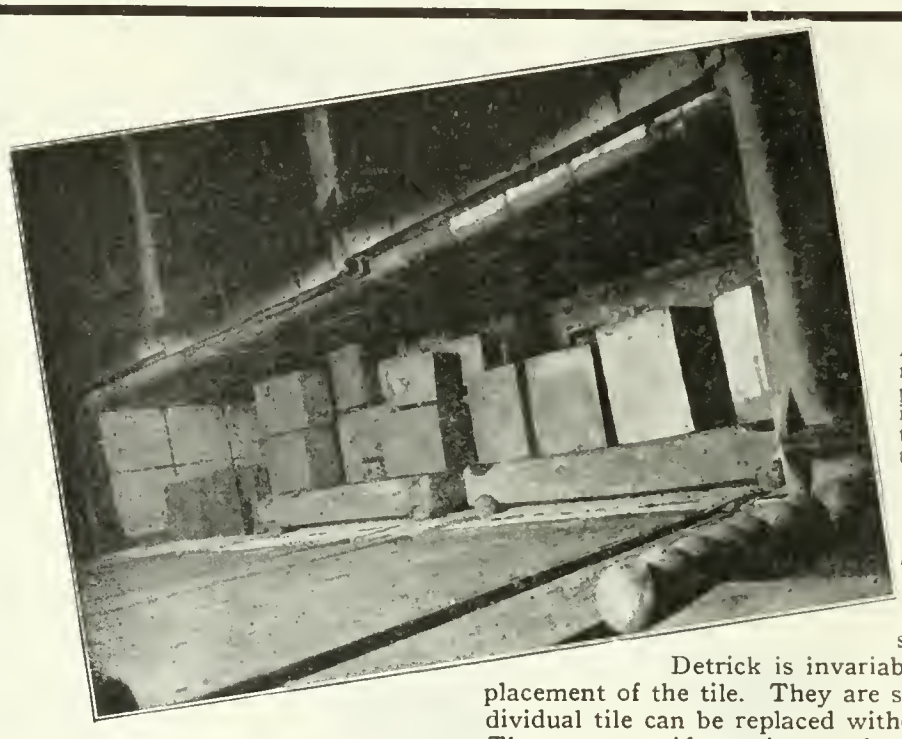
In the Steel Industry DETRICK Arches are Preferred



At the left is a photograph of an annealing oven at the Sizer Forge Company, Buffalo, N. Y. The Detrick Arch in this installation is 6 ft. long by 120 tile. As usual the arch is giving entire satisfaction.

THE success of the Detrick Flat Suspended Arch parallels its success in other fields. Where the service required of an arch is severe the Detrick is invariably preferred because of the ease of replacement of the tile. They are suspended like a pendulum and each individual tile can be replaced without disturbing the balance of the arch. There are no side strains on the boiler wall—the entire weight of the arch is exerted downward.

There are over 5,000 installations of Detrick Arches in America today. Most of these have been made by Detrick Engineers. Because of their wide experience in this field we have no hesitancy in recommending their services to anyone having boiler problems involving the use of an arch. You can secure their services by writing the nearest office.

These Leading Companies in the Steel Industry Have Installed Detrick Arches

American Rolling Mill Co.
American Steel Foundries
Bethlehem Steel Co.
Carnegie Steel Co.
Illinois Steel Co.
Jones & Laughlin Steel Co.
Parkersburg Iron Works
Pittsburgh Steel Products Co.
Republic Iron & Steel Co.
Carnegie Steel Works
American Steel & Wire Co.
Weirton Steel Co.
American Bridge Co.

M. H. DETRICK CO., 549 W. Washington Blvd. Chicago

New York Office, 30 Church St.

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Cincinnati, Ohio.....1103 Union Trust Bldg.
Cleveland, Ohio.....515 National City Bldg.
Chicago, Ill.....901 Marquette Bldg.
Milwaukee, Wis.....620 Wells Bldg.
Boston, Mass.....141 Milk St.
Hazelton, Pa. .....
Salt Lake City.....521 McIntyre Bldg.
New Orleans, La.....81 Baronne St.
Houston, Texas..Houston Land & Trust Bldg.
Denver, Colo.....1710 Glendon Pl.
Seattle, Wash. .....1307 L. C. Smith Bldg.
San Francisco, Calif.....507 New Call Bldg.
Atlanta, Ga.....619 Trust Co. of Georgia Bldg.
Detroit, Mich.....410 Moffat Bldg.
Indianapolis, Ind...305 Merchandise Bank Bldg.
Montreal, Canada.....20 St. Nicholas St.
Havana, Cuba .....

DETRICK FLAT SUSPENDED ARCHES

Co-operate:—Refer to The Blast Furnace and Steel Plant

ALLIS-CHALMERS Oil Engines Diesel Type

THE rapid adoption of oil engines of the Diesel type in nearly every branch of industry is recognized by engineers of the superior economy of this system of power generation.

Allis-Chalmers Oil Engines not only possess all the good features of the Diesel type but also many advantages derived from certain refinements of design and construction peculiar to the Allis-Chalmers development of this prime mover.

The choice between the fuel oils available is determined solely by the relative cost, heat value and convenience in handling, as this engine successfully uses any oil that can be pumped, even those that require pre-heating to make them flow readily through the piping.

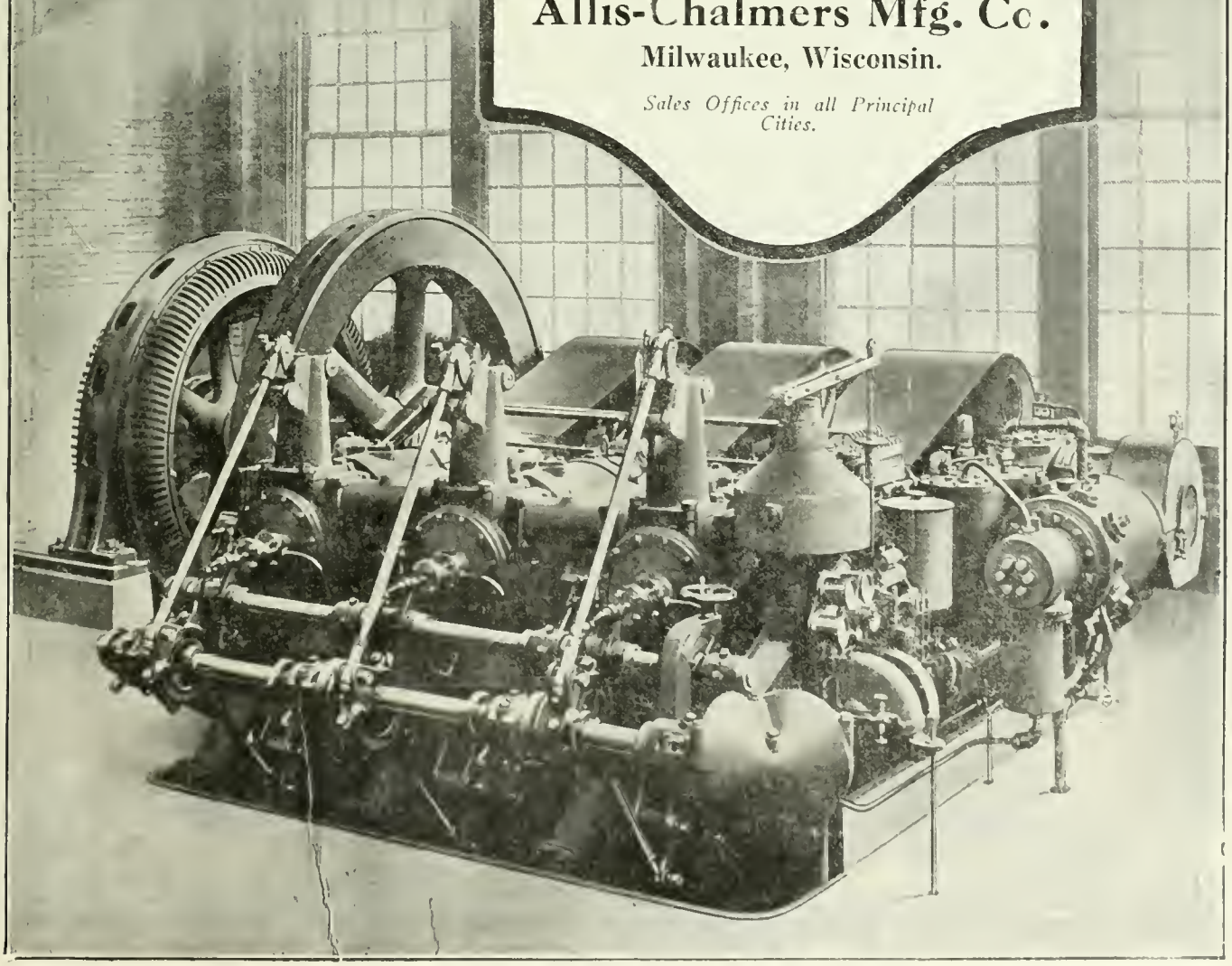
Allis-Chalmers Oil Engines are offered in sizes from 70 to 600 h.p., in one, two, three, four and six cylinder units, making a full line of sizes and cylinder arrangements for any condition of service for which gas or steam engines are suitable.

Shall we send you Bulletin No. 1532-J

Allis-Chalmers Mfg. Co.

Milwaukee, Wisconsin.

Sales Offices in all Principal Cities.



INGOT MOULDS

All Shapes and Sizes
Direct or Cupola Metal

Sprue Plates, Runners, Fountains,
Hearth Jackets, Cooling Plates,
Cinder Pots, Blast Furnace Bells,
Casting for Chemical Plants and

Miscellaneous Bessemer Iron Castings

Valley Mould and Iron Corporation
Sharpsville, Pa.

WORKS:

Pittsburgh, Pa.
Josephine, Pa.
Sharpsville, Pa.
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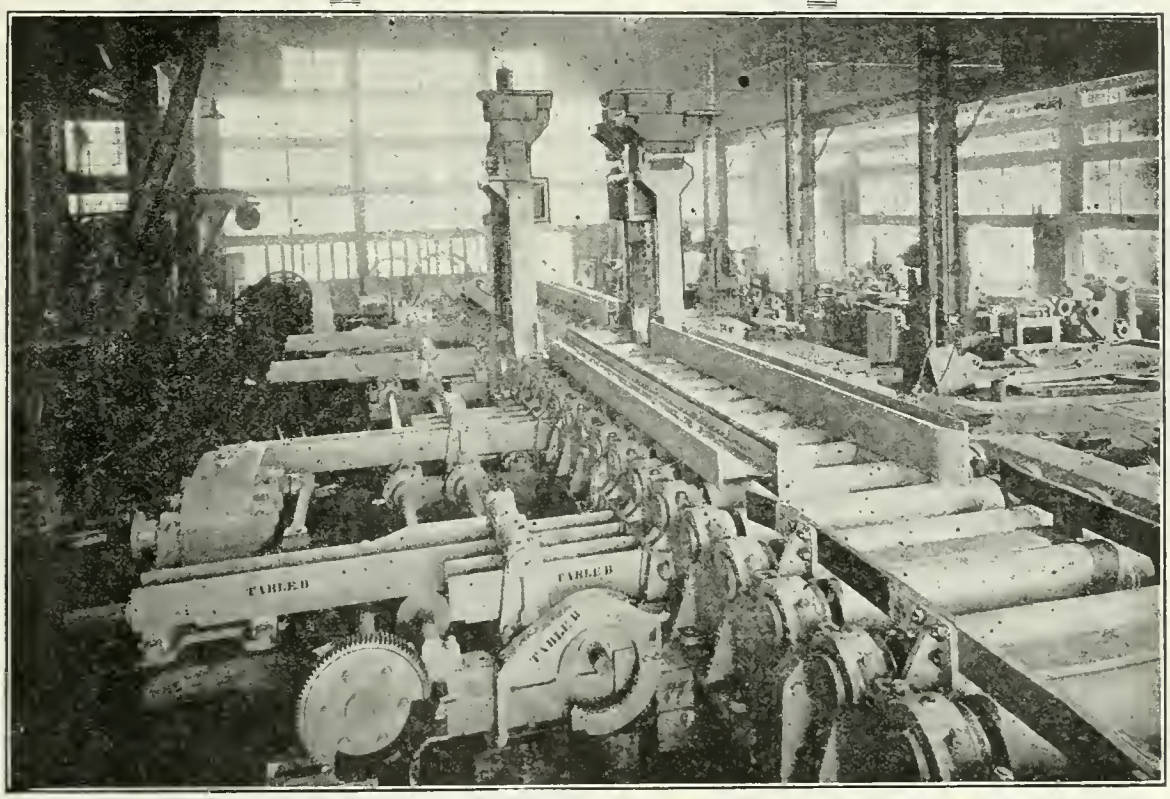
TREADWELL



34" Treadwell two-high Reversing Blooming Mill for the Automobile M. Berliet, Usines de Venissieux, Rhone, France, on our Erection floor.

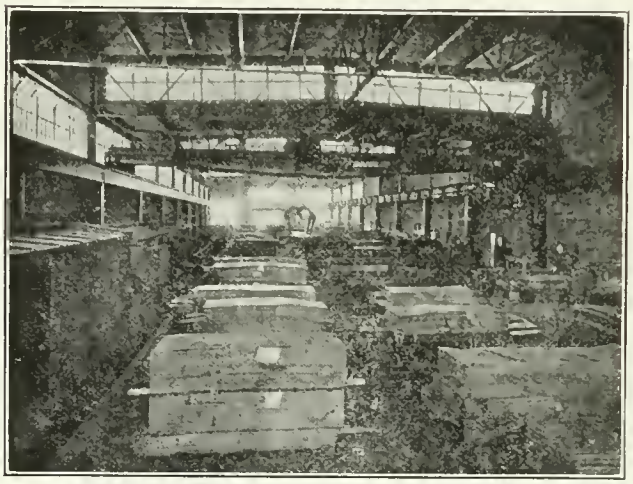
MODERN ROLLING MILL MACHINERY AND STEEL MILL EQUIPMENT

TREADWELL ENGINEERING COMPANY
EASTON, PA., U.S.A.

Co-operate:—Refer to The Blast Furnace and Steel Plant

355 Pounds of Coal per Ton of Sheets in Warehouse

This fuel record was obtained by using powdered coal, containing approximately 18% Ash prepared, transported and burned by the Quigley System.



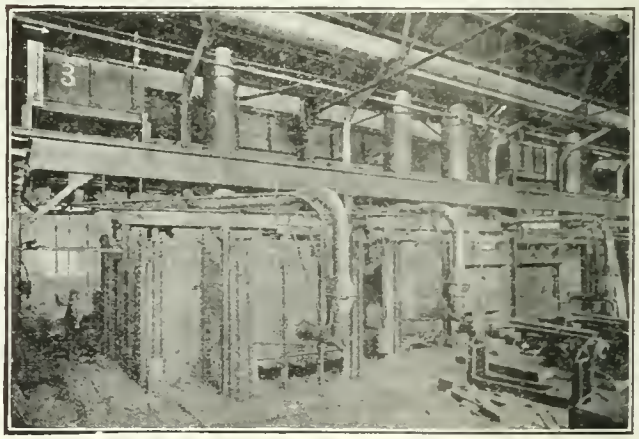
QUIGLEY POWDERED COAL SYSTEM SPEEDS PRODUCTION AND SAVES FUEL AND LABOR

The figures given represent the average consumption for a period of three months from April 1st to June 30th, 1920.

This includes coal for sheet mill boilers, sheet and pair furnaces, annealing furnaces and grease kettle—in other words, per ton of sheets in the warehouse. This output was secured by a sheet mill, in which the complete powdered coal system was furnished by the Quigley Furnace Specialties Co.

During one week of the period covered by the above figures, this plant established a record production of 1800 tons of sheets from eight mills.

Indications are that with further operation this tonnage will be increased.



QUIGLEY POWDERED COAL SYSTEM FOR FIRING SHEET AND PAIR FURNACES

Accurate records are made possible by our system of weighing and recording every pound of coal as it is distributed from milling plant to various points of consumption, giving an accurate daily check on each operation.

All installations of the Quigley System have given satisfactory production from the start of operations. We are effecting large economies in fuel consumption and at the same time reducing operating and labor costs coupled with a vast improvement in working conditions.

Quigley Furnace Specialties Company, Inc.

26 Cortlandt Street *Engineers and Contractors* **New York, N. Y.**

Complete Systems for preparing, transporting and burning Powdered Coal

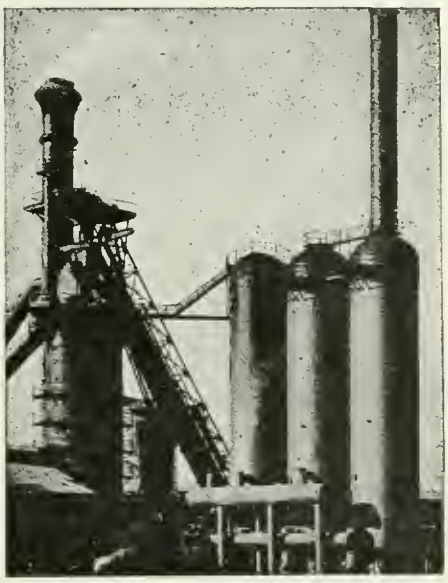
Sales Offices: Buffalo, Chicago, Denver, Pittsburgh

BULLETIN 11B ON REQUEST

Co-operate:—Refer to The Blast Furnace and Steel Plant

Service Rendered

The character and extent of the clientele of a professional or business concern is usually an excellent indication of the quality of service which it renders.



BLAST FURNACES
STEEL MILLS AND
AUXILIARY EQUIPMENT

Arthur G. McKee & Co.

ENGINEERS & CONTRACTORS
2422 EUCLID AVE.
CLEVELAND, O.

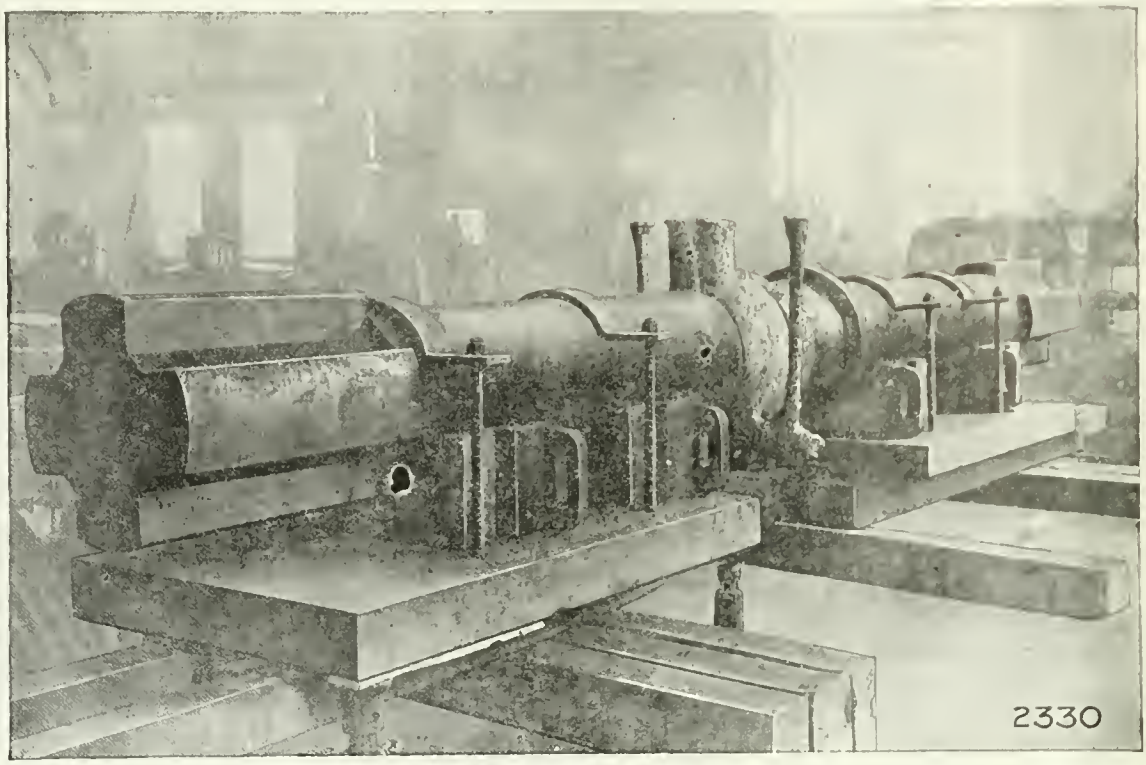
Blast Furnaces
Hot Blast Stoves
Storage Bins
McKee Revolving Distributors
Kling Weidlein Dry Gas Cleaners
Rolling Mills
Open-Hearth Furnaces
Power Plants

A list of our clients and customers to whom services have been rendered during the past fourteen years would form a "Blue Book" or "Who's Who" of the iron industry of America. It would include over 80% of the pig iron producers in the United States. Space does not permit a complete list of those to whom we have in the past furnished engineering services, equipment or construction. The following, however, is a partial list:

Algoma Steel Corp.
American Manganese Mfg. Co.
American Rolling Mill Co.
American Steel & Wire Co.
Bethlehem Steel Co.
Brier Hill Steel Co.
Buffalo-Union Furnace Co.
Cambria Steel Co.
Carbon Steel Co.
Carnegie Steel Co.
Central Iron & Coal Co.
Cleveland-Cliffe Iron Co.
Cleveland Furnace Co.
Clinton Iron & Steel Co.
Crane Iron Works.
Detroit Iron & Steel Co.
Donner Steel Co.
Eastern Steel Co.
Emporium Iron Co.
Hamilton Furnace Co.
Illinois Steel Co.
Indian Iron & Steel Co.
Inland Steel Co.
Iroquois Iron Co.
Jones & Laughlin Steel Co.
La Belle Iron Works.
Lackawanna Steel Co.
McKinney Steel Co.
Marting Iron & Steel Co.
National Tube Co.
Northwestern Iron Co.
Penn Iron & Coal Co.
Perry Iron Co.
Pittsburgh Crucible Steel Co.
Pulaski Iron Co.
Republic Iron & Steel Co.
Roane Iron Co.
Robesonia Iron Co.
Sloss-Sheffield Steel & Iron Co.
Standard Iron Co.
Struthers Furnace Co.
Thomas Furnace Co.
Thomas Iron Co.
Toledo Furnace Co.
United Iron & Steel Co.
Wayne Steel Co.
Weirton Steel Co.
Wellston Iron Furnace Co.
Wharton Steel Co.
Wickwire Steel Co.
Zenith Furnace Co.

Over 90% of our customers have given us "repeat orders"—in some instances 20 to 30 separate and distinct commissions.

Reports—Appraisals—Investigations



Don't Scrap Your Broken Spindles!

THERMIT WELDING

will put them back in service as strong and efficient as ever.

The above illustration shows one of several similar large spindles repaired by Thermit welding by the Brier Hill Steel Company, Youngstown, Ohio.

All of these broken spindles have been welded and restored to service, giving no trouble.

Thermit welding will do the same for your broken

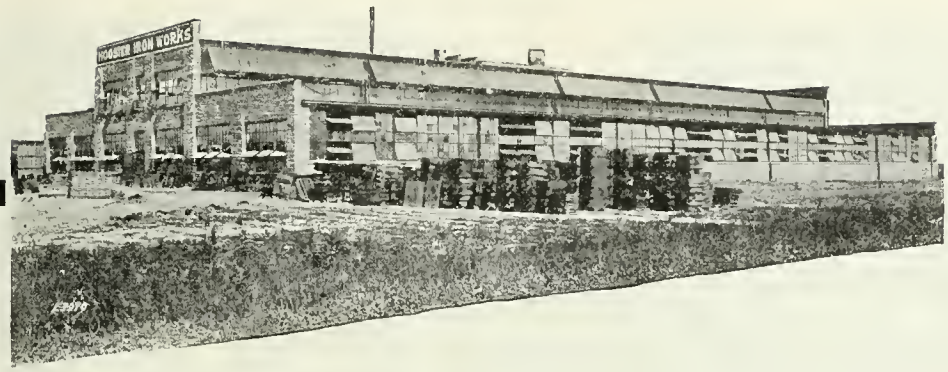
Crankshafts	Gear Wheels	Truck Frames
Rolls and Pinion Necks	Drop Forge Sections	Trimming Frames
Rolls and Pinion Pods	Steam Hammers	Pinion Teeth
Housings	Locomotive Frames	and other
Shears	Charging Rams	Heavy Steel Sections

Send for Pamphlet 1778.

METAL AND THERMIT CORPORATION

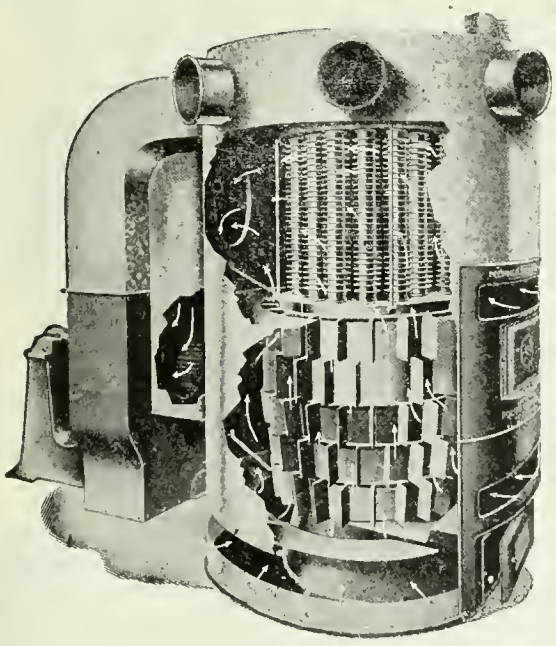
120 Broadway, New York City

1427 Western Ave., Pittsburgh
15 Emily St., Toronto, Ont.
7300 So. Chicago Ave., Chicago
329-333 Folsom St., San Francisco



This plant at Kokomo, Ind., was warmed and ventilated by a Gordon Mechanical Hot Blast Heater last year. This company and its affiliated corporations have ordered five more heaters, two to be used in an extension of this plant, two in the foundry they have leased and one in the Kokomo Brass Works now building.

"Gordon—A Guarantee of Dependable Service"



The Mechanical Hot Blast Heater employs simple but radically different principles from the old line of heaters. From this heater warm moist air is forced **horizontally** near the floor level in the direction desired. A multivane fan distributes the heat **direct** to the proper spot. This results in a tremendous saving of coal—a saving that will count for more this coming season than ever before.

IN a consideration of Robert Gordon, Inc., products, as the solution to your heating problems, it should be borne in mind that Robert Gordon, Inc., are essentially heating engineers. In their plans and deliberations the engineering phase of a heating problem is of primary consideration. Manufacturing correctly is a natural sequence.

Each Robert Gordon heating unit is designed to accomplish certain definite things under certain conditions just as definite. Generally speaking, these conditions are more or less standardized, and so the heating elements may be proportionately standardized.

For the protection of the buyer as well as ourselves we take the attitude that we must determine the fitness of our products for your purposes before you can buy. This is not necessarily a high-minded or altruistic policy—it is plain good business.

Therefore we have no hesitancy in saying "Gordon—A Guarantee of Dependable Service"—the name must not mean anything less. And this is further backed by the fact that thousands of heating installations have been made by this organization without a failure.

The following are only a few of the many foundries and other industries that have installed Robert Gordon, Inc., heating systems. Their expressions should be worth a lot to you in making your decision.

Peerless Foundry Co., Cincinnati, Ohio.
New Idea Spreader Co., Coldwater, Ohio.
Hardened Steel Products Co., Detroit, Michigan.
Red Jacket Mfg. Co., Davenport, Iowa.
LaPorte Foundry & Furnace Co., LaPorte, Ind.
Standard Steel Castings Co., Chicago, Ill.
Feed Furnace Co., Oaks, Pa.
Geneva Foundry & Machine Co., Geneva, Ill.
Werra Aluminum Foundry Co., Mishawaka, Ind.
Waukesha, Wisconsin.
General Pattern Works, Cincinnati, Ohio.

Drop us a line today for the most interesting facts about foundry heating you have ever read.

ROBERT GORDON, Inc.

632 W. MONROE ST. CHICAGO

BRANCH OFFICES

Grand Central Palace, New York; Bessemer Bldg., Pittsburgh; Sun Bldg., Detroit.

Canadian Agents: E. J. Woodison Co., Ltd., Toronto and Montreal.

Let us get together at the Annual Convention and Exhibition of the American Foundrymen's Association—Columbus, O., October 4th-8th.

You shouldn't miss this opportunity to see, at close range, how the best practice and principles of heating engineering may be applied to your warming and ventilating problems through Robert Gordon, Inc., products.

Co-operate:—Refer to The Blast Furnace and Steel Plant

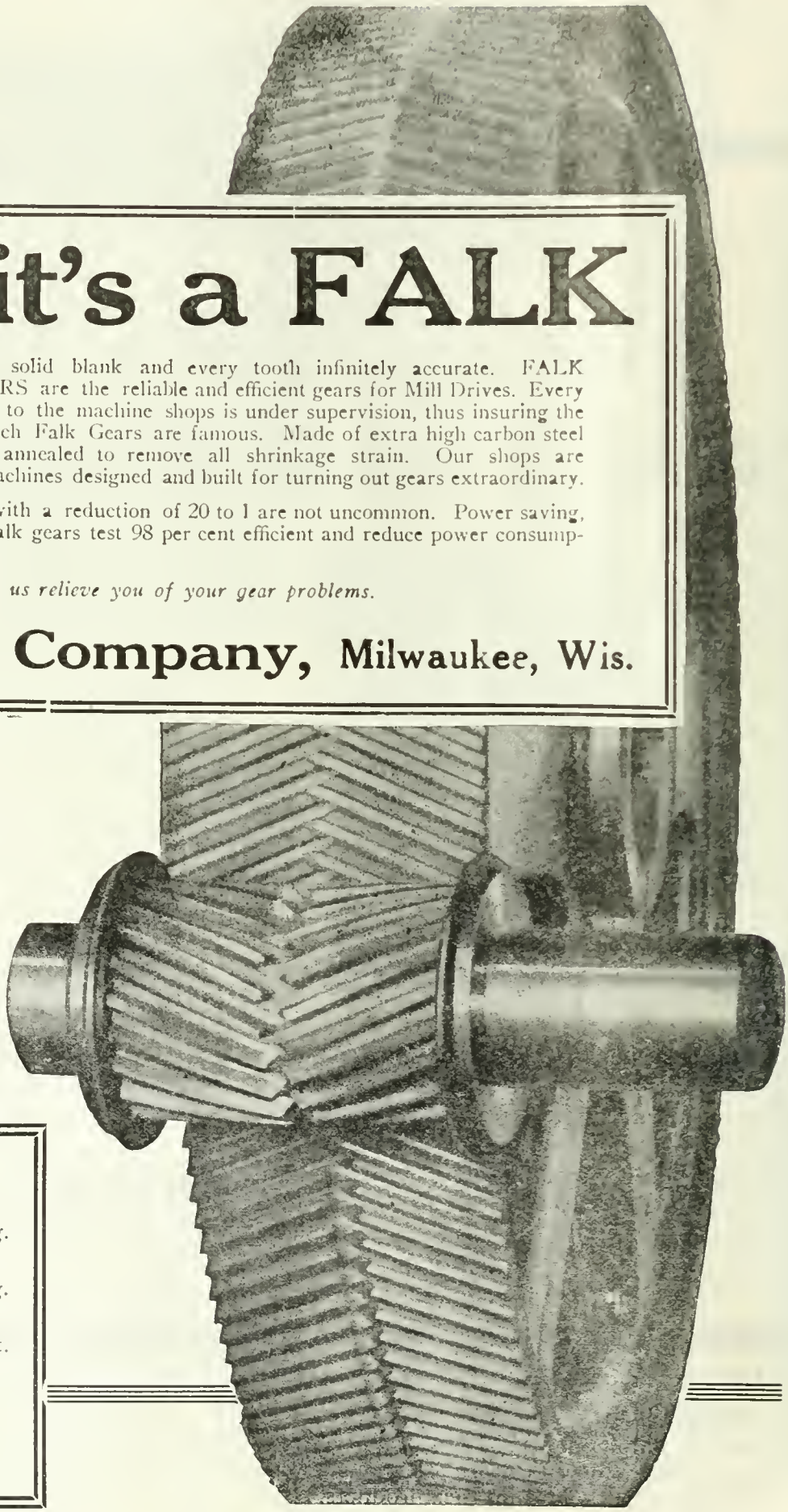
Yes, it's a FALK

Hobbed from a solid blank and every tooth infinitely accurate. FALK HERRINGBONE GEARS are the reliable and efficient gears for Mill Drives. Every operation from foundry to the machine shops is under supervision, thus insuring the uniform quality for which Falk Gears are famous. Made of extra high carbon steel castings and thoroughly annealed to remove all shrinkage strain. Our shops are equipped with special machines designed and built for turning out gears extraordinary.

FALK GEARS with a reduction of 20 to 1 are not uncommon. Power saving, positive and efficient. Falk gears test 98 per cent efficient and reduce power consumption 15 per cent.

Let us relieve you of your gear problems.

The Falk Company, Milwaukee, Wis.



Representatives:

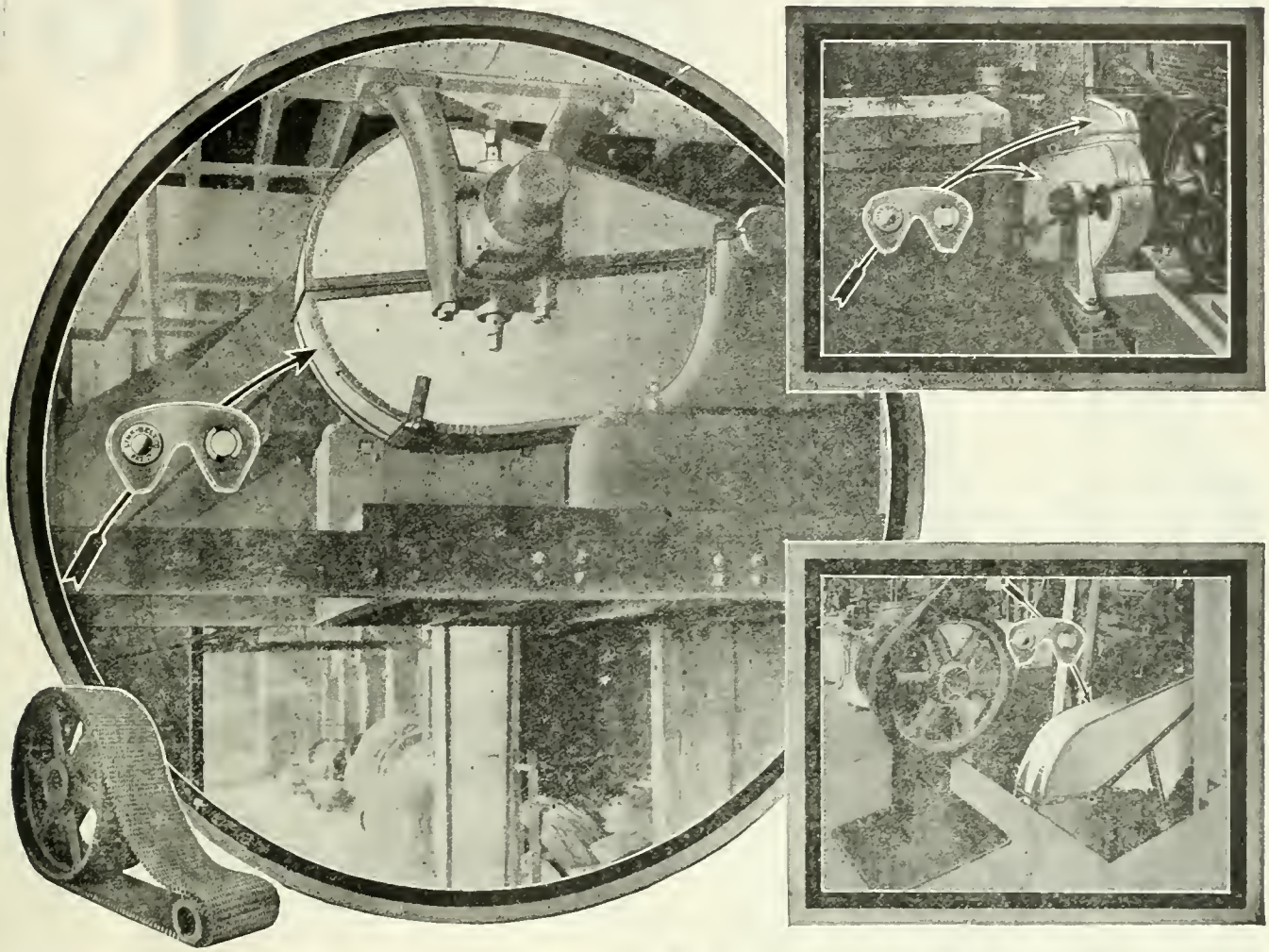
Pittsburgh,
W. O. Beyer, 1007 Park Bldg.

San Francisco,
F. W. Grimwood, Rialto Bldg.

New York,
M. P. Fillingham, 50 Church St.

Wilkes-Barre,
Vulcan Iron Works.

Denver,
Denver Engineering Works.



The Positive, Non-Slipping Drive For Steel Plants

LINK-BELT Silent Chain can pull your load under all operating conditions, without slip, without loss of power. That is one of the reasons for the intensive production it gets from the machines it operates. It delivers 98.2% of the motor's power to the driven machine. The machine hands can concentrate on production. They are relieved of all care and worry about the transmission.

Link-Belt Silent Chain Drives have proved their reliability in steel and iron production by successful service in driving practically all types of steel plant equipment.

Let us refer you to Link-Belt Silent Chain Drives in your vicinity. Get acquainted with them operating under conditions similar to yours.

Data Book No. 125, our 128 page price-list, is a handbook of efficient power transmission. Send for a copy today It shows how to figure drives, and to determine prices.

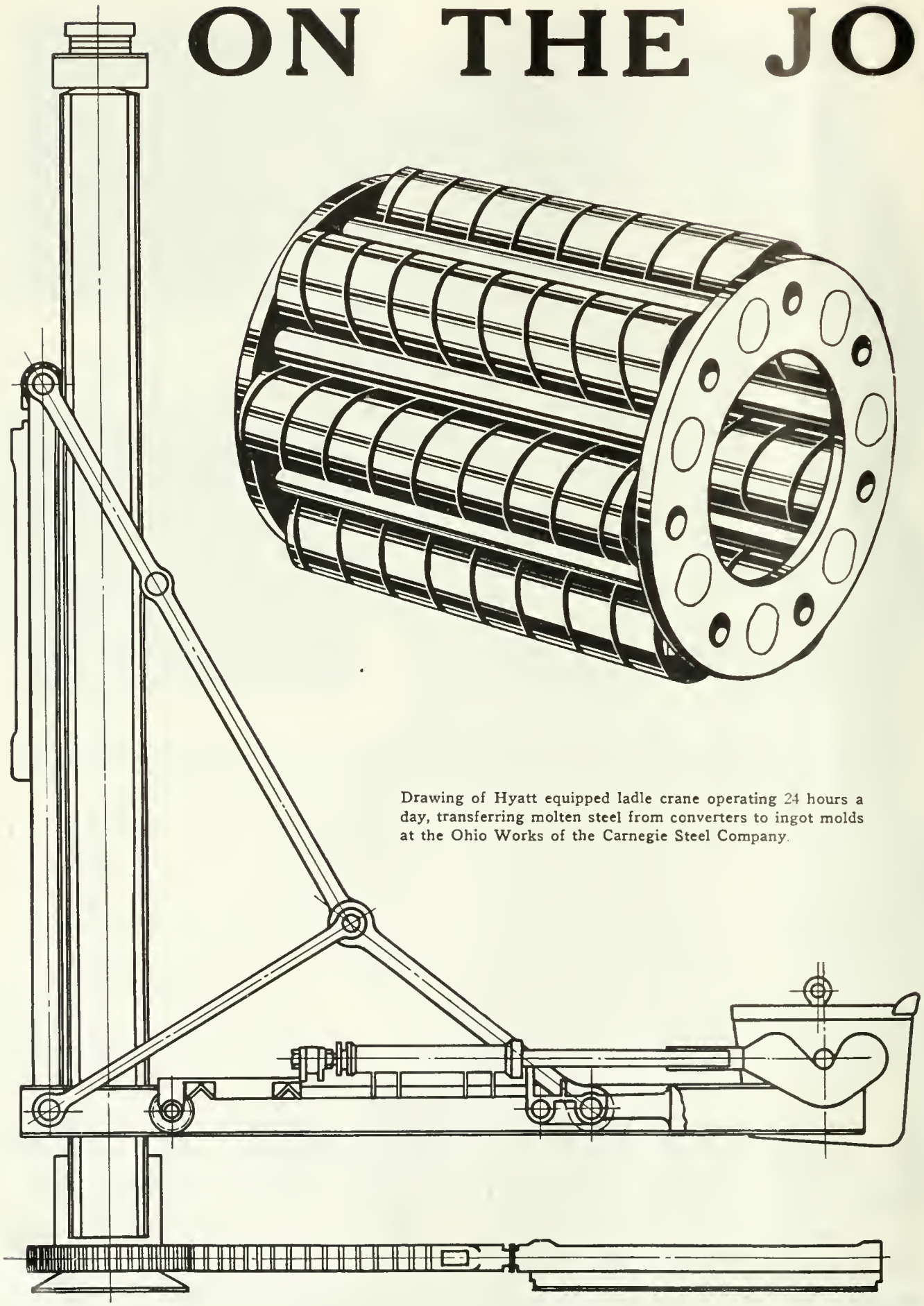
LINK-BELT COMPANY

PHILADELPHIA	CHICAGO		INDIANAPOLIS	
New York	299 Broadway	Kansas City, Mo	306 Elmhurst Bldg	
Boston 9	49 Federal St	Seattle	820 First Ave. S	
Pittsburgh	1901 Park Bldg	Portland, Ore	First and Stark Sts	
St. Louis	Central Nat'l Bank Bldg	San Francisco	168 Second St	
Buffalo	847 Ellicott Square	Los Angeles	163 N. Los Angeles St	
Wilkes-Barre	24 Nat'l Bank Bldg	Toronto, Can	Canadian Link-Belt Co. Ltd	
Huntington, W. Va	Robson-Prichard Bldg	Denver	Lindrooth, Shubart & Co.	Boston Bldg
Cleveland	429 Kirby Bldg	Louisville, Ky	Frederick Wehle-Starks Bldg	
Detroit	4210 Woodward Ave	New Orleans	C. O. Hinz, Hibernia Bank Bldg	
Minneapolis	418 S. Third St	Birmingham, Ala	S. L. Morrow, 720 Brown-Marx Bldg	
Charlotte, N. C.	...		J. S. Cothran, Com'l Bank Bldg	

LINK-BELT
SILENT CHAIN DRIVES

Co-operate:—Refer to The Blast Furnace and Steel Plant

ON THE JOB



Drawing of Hyatt equipped ladle crane operating 24 hours a day, transferring molten steel from converters to ingot molds at the Ohio Works of the Carnegie Steel Company.

24 HOURS A DAY

AT the Ohio Works of the Carnegie Steel Company, Hyatt Roller Bearings are operating continuously 24 hours a day in a 20 ton ladle crane which transfers steel from the Bessemer converters to the ingot molds.

To keep up the continuous transfer of hot metal from the converters to the molds, this crane must be absolutely dependable. And the bearings—the vital parts of any crane—are an important factor in securing this dependability.

The sturdy Hyatt Roller Bearings are not affected by the intense heat from the converters and from the hot steel; nor by the large amount of dirt which creeps in.

In addition by applying Hyatt Roller Bearings to this crane the hydraulic pressure by which it is operated is reduced 25 per cent—from 800 to 600 pounds.

It will pay you to equip your cranes, large or small, with Hyatt Roller Bearings. Send for our complete engineering data on cranes.

B-718

HYATT ROLLER BEARING COMPANY
INDUSTRIAL BEARINGS DIVISION
NEW YORK, N. Y.

MOTOR BEARINGS DIVISION, DETROIT, MICH.

TRACTOR BEARINGS DIVISION, CHICAGO, ILL.

Manufacturers of Bearings for Mine Cars, Ore Cars, Steel Mill Cars, Roller Tables, Trolleys, Cranes, Hoists, Machine Tools, Line Shafts, Countershafts, Concrete Machinery, Textile Machinery, Conveyors, Lift Trucks, Industrial Trucks, Railway Service, Cars, Storage Battery Locomotives, etc.

HYATT ROLLER BEARINGS FOR CRANES

Co-operate:—Refer to The Blast Furnace and Steel Plant

GRAVER
Water
Softening & Purification
HEADQUARTERS

HARD WATER *is costing American Manufacturers Millions of dollars annually*

American Industry is now learning, as European industry learned years ago, of the great waste due to the use of hard water where soft water should be used.

Hard water used in the boilers of power plants costs manufacturers millions of dollars annually in increased consumption of coal, in lessened efficiency of their plants, in the labor spent in cleaning boiler tubes, in the investment carried in extra boilers kept for "throwing in" while others are withdrawn for cleaning.

Hard water used in textile mills, laundries, ice-plants and other water-using industries hinders production, wastes material, and lowers the quality of the product.

There is today a Headquarters for the handling of all water-using problems by competent engineers equipped with every facility. This corporation, for years designers, manufacturers and builders of water softening and purifying apparatus, provides water softeners and filters of *all* approved types, and in all required sizes.

Its service is analytical, advisory, and supervisory, in addition to its ability to manufacture and install any needed equipment.

GRAVER

Hot or Cold Processes
Continuous Water Softeners
Intermittent Water Softeners
Zeolite Water Softeners
Pressure and Gravity Filters
Feed Water Heaters
Hot Water Service Heaters

Confer with your consulting engineer or architect or write us direct for full information regarding the application of Graver Service to your line of business.

GRAVER *Corporation*

(WM. GRAVER TANK WORKS · FOUNDED 1857)

Steel Tanks and General Steel Plate Construction
Water Softening and Purifying Equipment

East Chicago, Indiana

3-B

Co-operate:—Refer to The Blast Furnace and Steel Plant

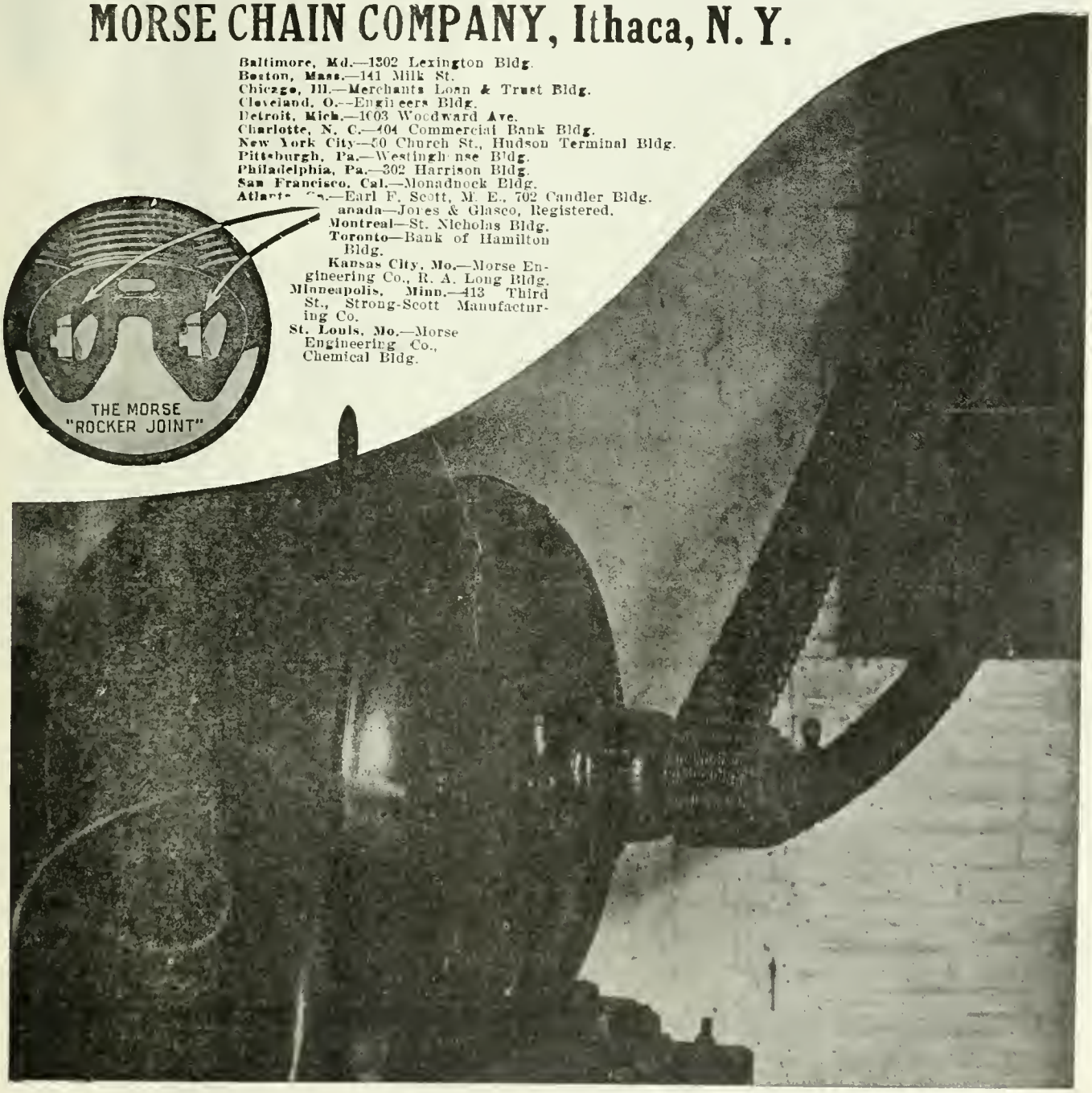
A Service that demanded a Morse Drive

The installation shown below is but one of a number of Morse Silent Chain Drives installed in the plant of the McKeesport Tin Plate Company, McKeesport, Pa. These drives operate tinning machines and are subjected to practically continuous service. They can be expected to remain on the job indefinitely without fear of their stretching and slipping, or wearing down and driving hard and noisily. That is why the specification called for Morse Silent Chain Drives.

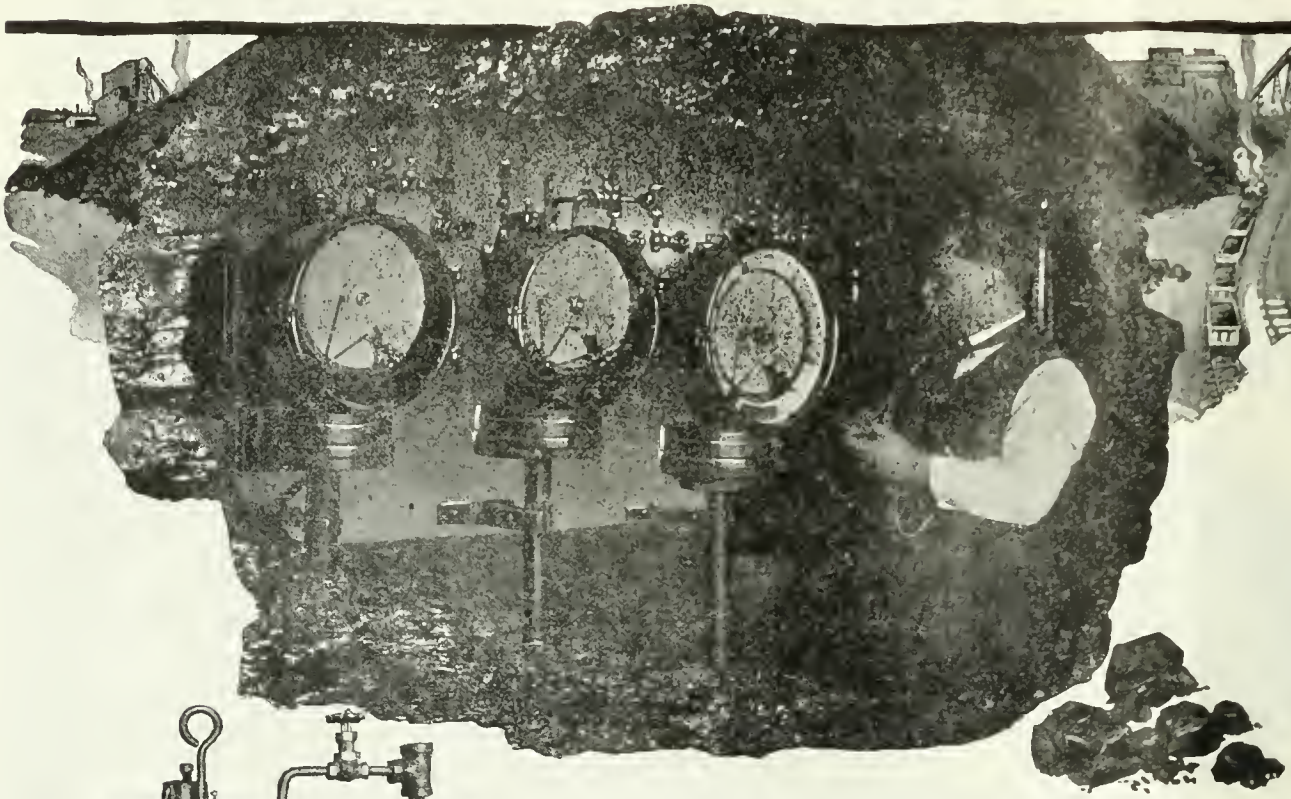
Perhaps you have some difficult drive problem to solve or some drive for special service, if so, why not submit the problem to Morse Engineers and let them help plan your drives.

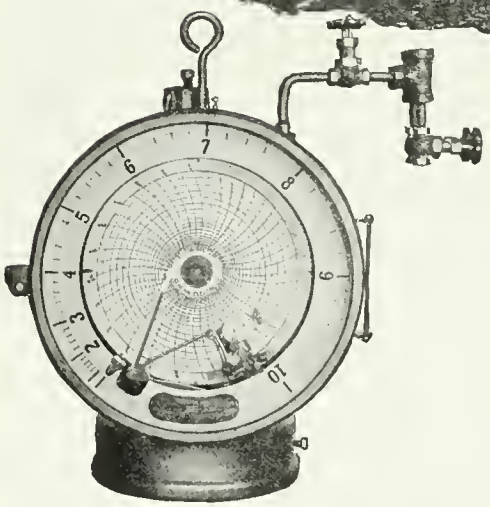
MORSE CHAIN COMPANY, Ithaca, N. Y.

Baltimore, Md.—1302 Lexington Bldg.
Boston, Mass.—141 Milk St.
Chicago, Ill.—Merchants Loan & Trust Bldg.
Cleveland, O.—Engineers Bldg.
Detroit, Mich.—1003 Woodward Ave.
Charlotte, N. C.—404 Commercial Bank Bldg.
New York City—50 Church St., Hudson Terminal Bldg.
Pittsburgh, Pa.—Westinghouse Bldg.
Philadelphia, Pa.—302 Harrison Bldg.
San Francisco, Cal.—Monadnock Bldg.
Atlanta, Ga.—Earl F. Scott, M. E., 702 Candler Bldg.
Canada—Jones & Glasco, Registered.
Montreal—St. Nicholas Bldg.
Toronto—Bank of Hamilton Bldg.
Kansas City, Mo.—Morse Engineering Co., R. A. Long Bldg.
Minneapolis, Minn.—413 Third St., Strong-Scott Manufacturing Co.
St. Louis, Mo.—Morse Engineering Co., Chemical Bldg.



If asked to report on your annual coal consumption could you swear that every ton had been efficiently utilized?





G-E Indicating, Recording, Integrating Flow Meter

A Real Efficiency Expert— G-E Flow Meter

POINT out inefficient boiler operation due to careless firing, incorrect adjustment of draft, dirty tubes, leaky settings, burnt out baffles, etc.

Why waste coal when it is so easy to save it.

Many steam plants have been able to pay for their G-E Flow Meters in a few months, from the savings which they have produced.

All G-E Flow Meters are simple, reliable and accurate, requiring only reasonable care for satisfactory operation.

Write our nearest office for booklet "A Guide to Boiler Economy" and Bulletin 46501 B, describing G-E Flow Meters for all applications.

General Electric Company

General Office Schenectady, N.Y.

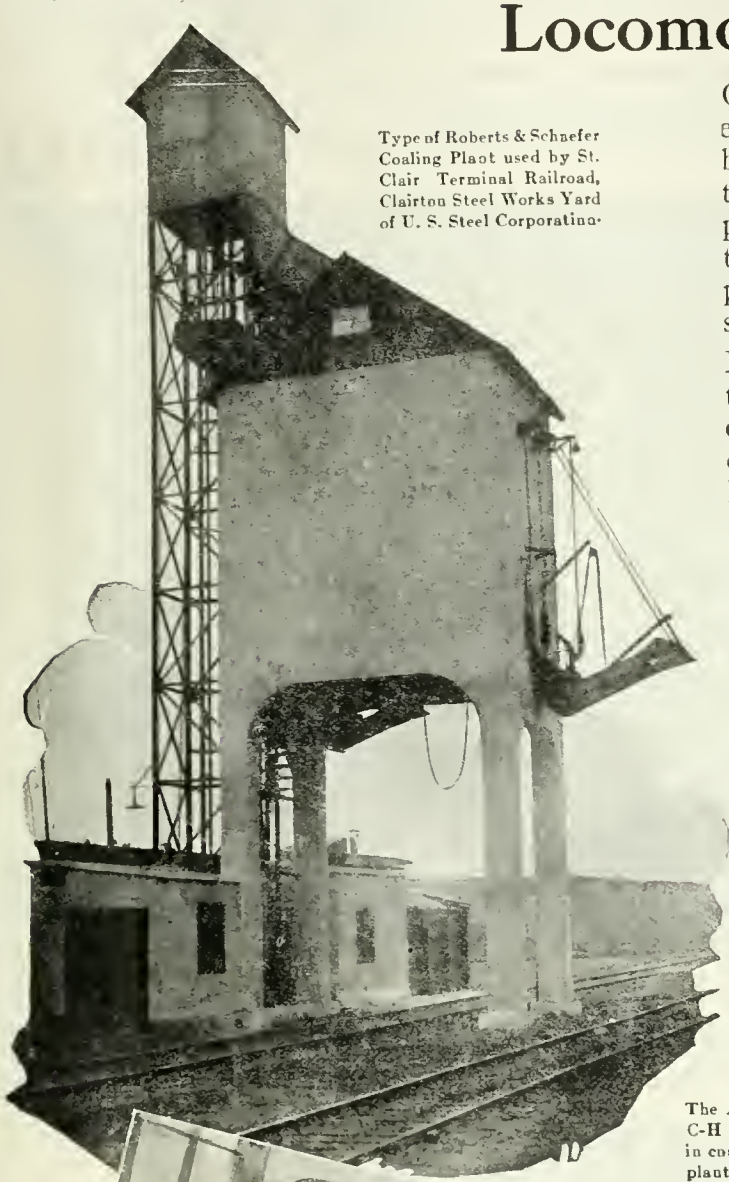
Sales Offices in all large cities

34C-B6

Co-operate:—Refer to The Blast Furnace and Steel Plant

A. I. & S. E. E. Convention, September 20th to 24th, New York City. C-H Exhibit, Booths 68 and 69.

Controlling the Modern Locomotive Coaling Plant



Type of Roberts & Schaefer Coaling Plant used by St. Clair Terminal Railroad, Clairton Steel Works Yard of U. S. Steel Corporation.

Operating the push buttons outside the enclosing case of the C-H Controller shown below is all the attendant need do to control the operation of the modern coaling plant. As if the human brain were acting, the magnetic switches on the controller panel start the motor driving the hoist, speed it up, slow it down, stop it.

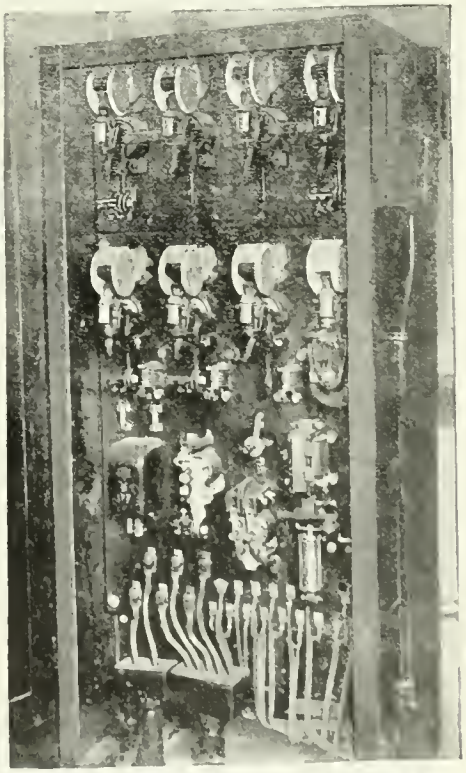
Every action of the hoist responds to the touch of a button. Such is the control incorporated in the modern coaling plant, one of which, designed and built by the Roberts & Schaefer Company for the St. Clair Terminal Railroad of the U. S. Steel Corporation, is here illustrated.

The accuracy and the scope of C-H Controllers are two of the reasons why it has been possible to apply motors successfully to so many industries and to so many types of coal and ore handling machinery. When considering the application of motors, get in touch with the nearest C-H office.

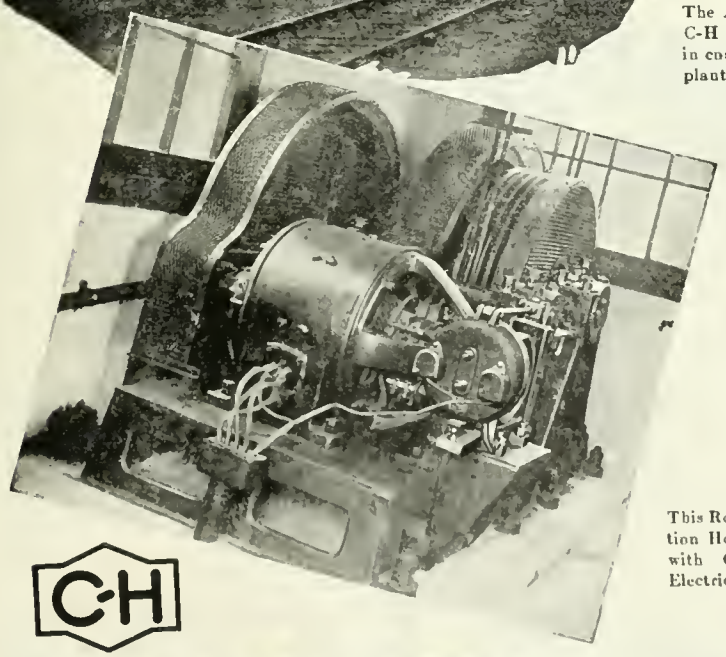
THE CUTLER-HAMMER MFG. CO.

Branch Offices: New York, Chicago, Pittsburgh, Boston, Cleveland, Philadelphia, Cincinnati, Detroit, San Francisco, Los Angeles, Seattle, Birmingham, Denver, Salt Lake City, Northern Electric Company, Ltd., Canada, and Igranic Electric Co., Ltd., Bedford and London, England.

WORKS: MILWAUKEE AND NEW YORK



The Automatic Type C-H Controller used in controlling coaling plants.



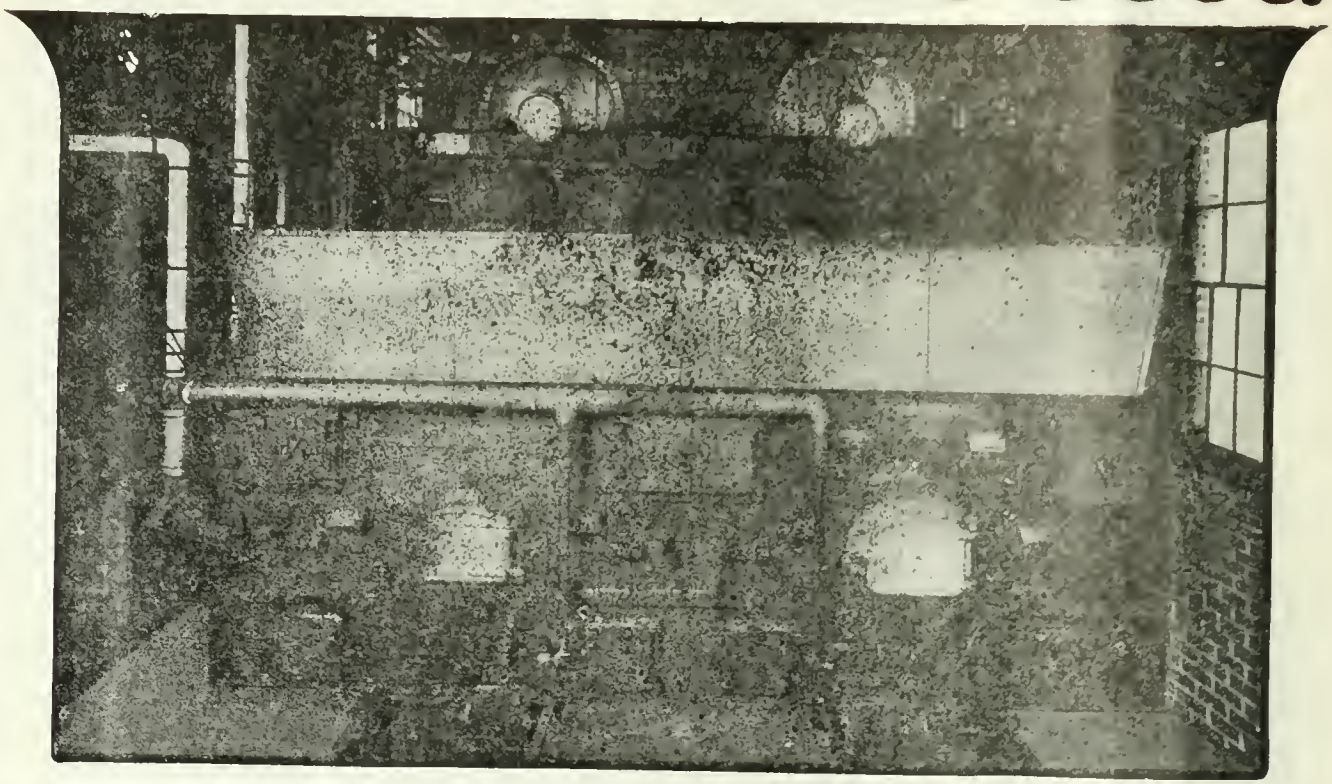
This Ross Patent Traction Hoist is equipped with C-H Type M Electric Brake.

C-H

CUTLER-HAMMER

Co-operate:—Refer to The Blast Furnace and Steel Plant

Where Coal is Cheapest
More Stokers Are Used



Naturally, coal is cheaper in the Pittsburgh district, yet the small plants, such as laundries, school houses, hospitals, etc., see that it is good business to save their fuel by installing

MURPHY AUTOMATIC FURNACES

One greenhouse, having boilers of only 75 horsepower each, installed a Murphy Furnace on trial. The coal saving was so great that another Murphy was put in. Soon nine other greenhouses followed suit. Even though these plants operated only 4 to 5 months in the year—the 15 to 30 per cent saving was very attractive.

Your plant, whether operating 12 months on power load—or a shorter period on a heating load, will be improved and fuel saved with Murphy Furnaces. You don't need to be told that low-priced coal has gone forever, and a ton saved now pays larger dividends—but if you want to burn any fuel that has heat in it—install the Murphy.

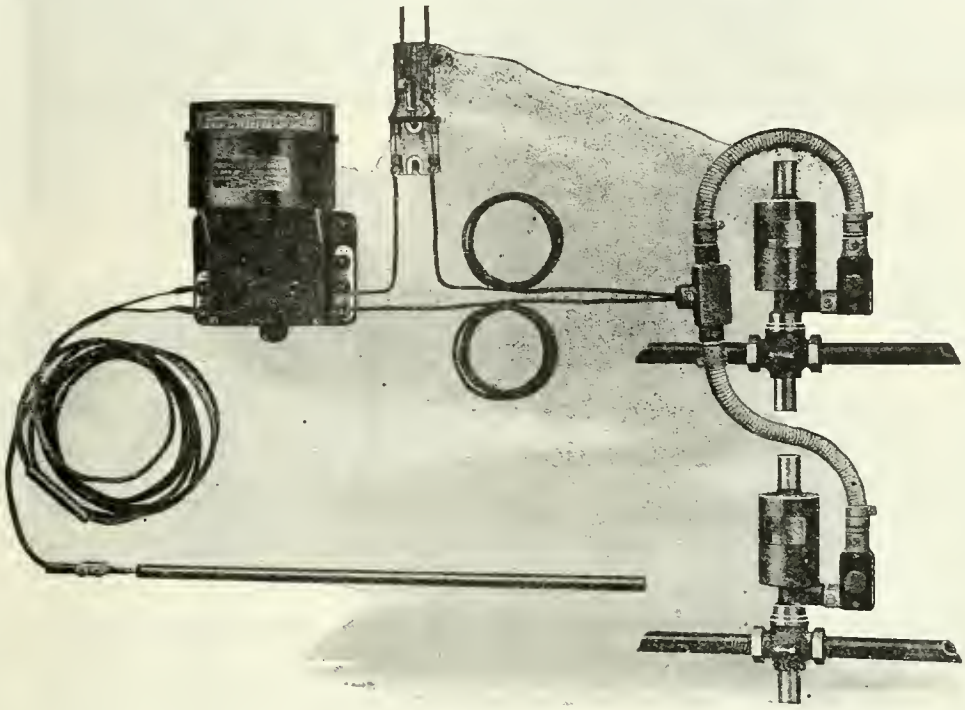
Catalog B-9 shows how Murphy Furnaces can be installed under any type of boiler—50 H.P. and up.

MURPHY IRON WORKS, Detroit, Michigan

BURN ANY FUEL THAT HAS HEAT IN IT

Co-operate:—Refer to The Blast Furnace and Steel Plant

Correct Temperatures Insured



Bristol's Complete Pyrometer Regulator for Gas or Oil Fired Furnaces.

Automatic mechanical temperature regulation on furnaces and ovens heated by means of gas, oil or electricity is positively obtained with Bristol's Temperature Controllers. Set the indicator at the degree of heat desired—the controller apparatus will take care of the rest. This applies to all temperatures up to 3,000° F.

TRADE MARK
BRISTOL'S
REG. U.S. PAT. OFFICE.

TEMPERATURE CONTROLLERS

Eliminate the human element of manual control.

Do the same amount of work with less help.

Secure greater economy in fuel. Give uniform results day after day and no spoiled work due to wrong heat treating.

These statements are all based on facts obtained from experiences with hundreds of Bristol's Automatic Temperature Controllers now in successful operation.

The simplicity of the Controlling Equipment is a potent factor in making them practical for every day commercial work. Because of this simplicity of the apparatus requires very little attention while in service.

Bulletin AD-289 tells more about these controllers. Where shall we send your copy?

THE BRISTOL COMPANY
WATERBURY, CONN.

RILEY UNDERFEED STOKERS

Burn All Grades of Coal

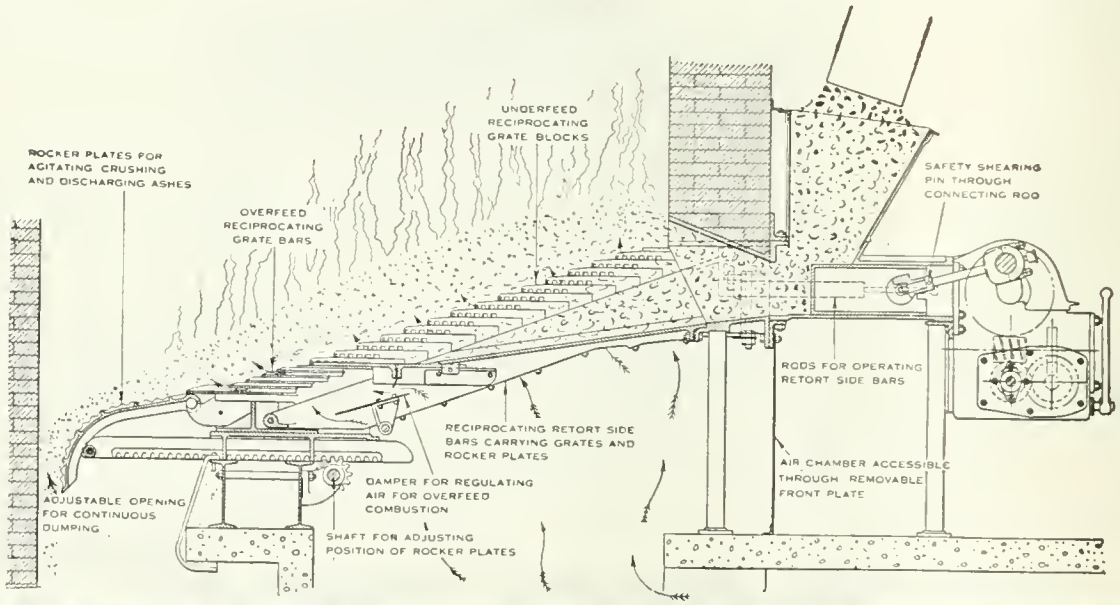
No device has shown itself better adapted to burn any available coal than the Riley Underfeed Stoker.

Low grade coals—those high in ash—in sulphur and clinker-forming qualities—can be handled successfully for the following reasons:

1. The *moving grates* keep the clinkers broken up—combustion is intensified—the fuel bed is always active, even and in a homogeneous state.
2. The *rocker dump*, with its combination of vertical thrust and rocking motion, grinds up—discharges the ash continuously and automatically—keeps the fire clean and the bridge wall free from accumulations.
3. The *underfeed* feature makes possible high capacity and instant response to overload demands.

Our engineers will be glad to acquaint you with the wide range of fuels *now* being handled by the Riley Underfeed Stoker under many varying conditions.

Write for Catalog B-9.


ROCKER PLATES FOR AGITATING CRUSHING AND DISCHARGING ASHES
OVERFEED RECIPROCATING GRATE BARS
UNDERFEED RECIPROCATING GRATE BLOCKS
SAFETY SHEARING PIN THROUGH CONNECTING ROD
RODS FOR OPERATING RETORT SIDE BARS
RECIPROCATING RETORT SIDE BARS CARRYING GRATES AND ROCKER PLATES
AIR CHAMBER ACCESSIBLE THROUGH REMOVABLE FRONT PLATE
DAMPER FOR REGULATING AIR FOR OVERFEED COMBUSTION
ADJUSTABLE OPENING FOR CONTINUOUS DUMPING
SHAFT FOR ADJUSTING POSITION OF ROCKER PLATES

SANFORD RILEY STOKER CO., WORCESTER, MASS.

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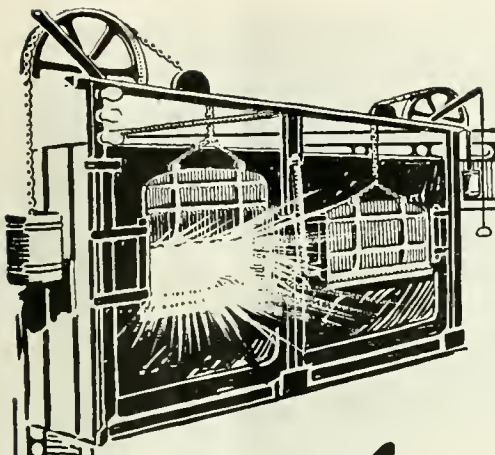
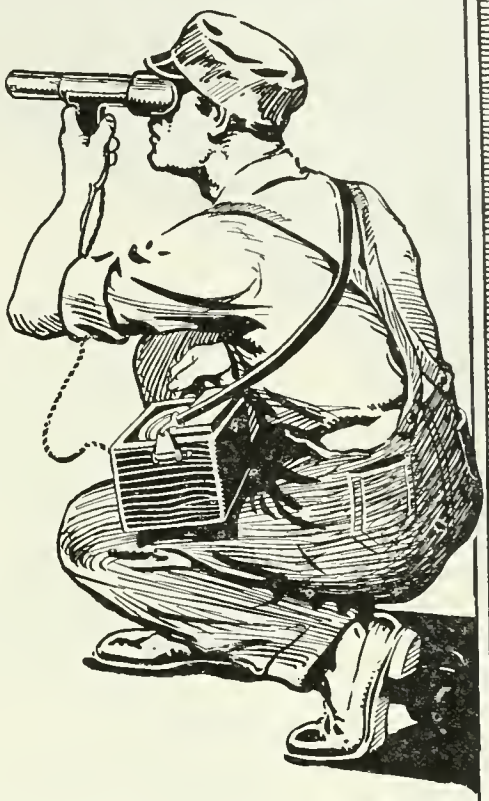




Check Thermocouples In Place

by means of the Leeds & Northrup Optical Pyrometer

This instrument measures the temperature of the spot at which it is sighted.

By sighting upon the protecting tube of a thermocouple, inaccuracies in the indications of the latter can be detected. Leeds & Northrup Optical Pyrometers were used in this manner by U. S. Army Inspectors for checking thermocouple equipments in plants throughout the country.

The optical pyrometer can be carried from furnace to furnace and successive calibrations made much more quickly than by means of a standard thermocouple inserted into the furnace near the working couple.

The optical pyrometer is also used to explore furnace interiors, thus ascertaining whether or not the temperatures indicated by the thermocouples are representative.

Nearness to the hot object or large areas to sight at are not required. Color-blindness and similar defects of vision do not vitiate results, as different observers agree within 10° F.

The Leeds & Northrup Optical Pyrometer, complete with battery, rheostat and milliammeter in a case to be slung from the shoulder, is sent, subject to return in 10 days or payment in 20 days to anyone supplying good references.

No. 8600 Optical Pyrometer, range 1,100 to 2,500° F. $105.25

No. 8610 Optical Pyrometer, range 1,100 to 3,200° F. 184.25

The Leeds & Northrup Company

4901 Stenton Ave., Philadelphia, Pa.

62

Turbo Blowers and Compressors

THE Ingersoll-Rand Company builds Turbo Blowers and Turbo Compressors in a wide range of capacities and pressure requirements. Machines in service have over and over again demonstrated the superior efficiency and reliability of I-R Turbo design.

We have furnished a great number of Turbo Blowers for Blast Furnaces, Bessemer Converters, Oil Furnaces, Oil Flotation, Cupola Blast and for other work calling for low pressure air or gas. Turbo Compressors for higher pressures are found in large industrial plants, where a large supply of compressed air is needed.

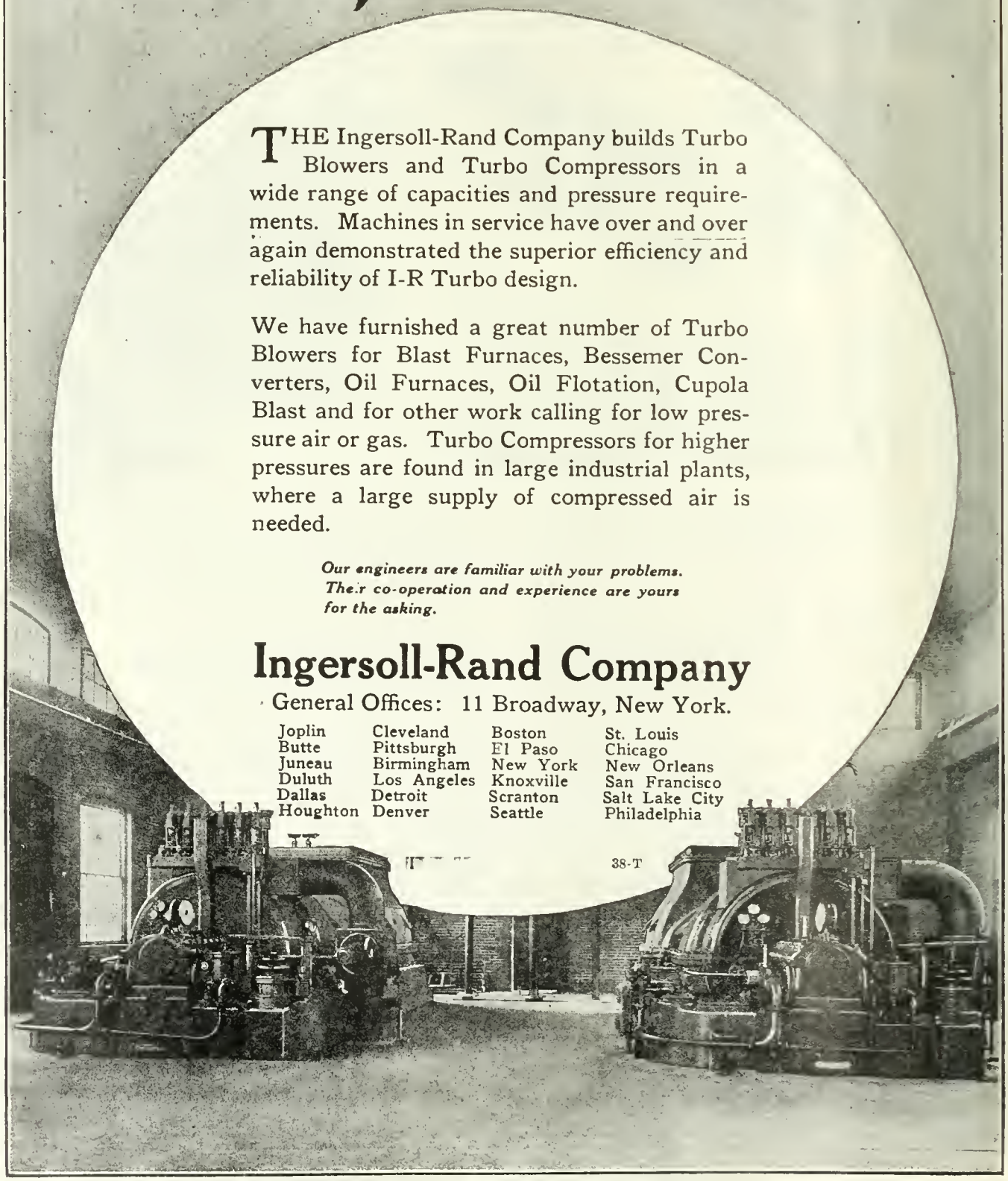
Our engineers are familiar with your problems. Their co-operation and experience are yours for the asking.

Ingersoll-Rand Company

General Offices: 11 Broadway, New York.

Joplin	Cleveland	Boston	St. Louis
Butte	Pittsburgh	El Paso	Chicago
Juneau	Birmingham	New York	New Orleans
Duluth	Los Angeles	Knoxville	San Francisco
Dallas	Detroit	Scranton	Salt Lake City
Houghton	Denver	Seattle	Philadelphia

38-T



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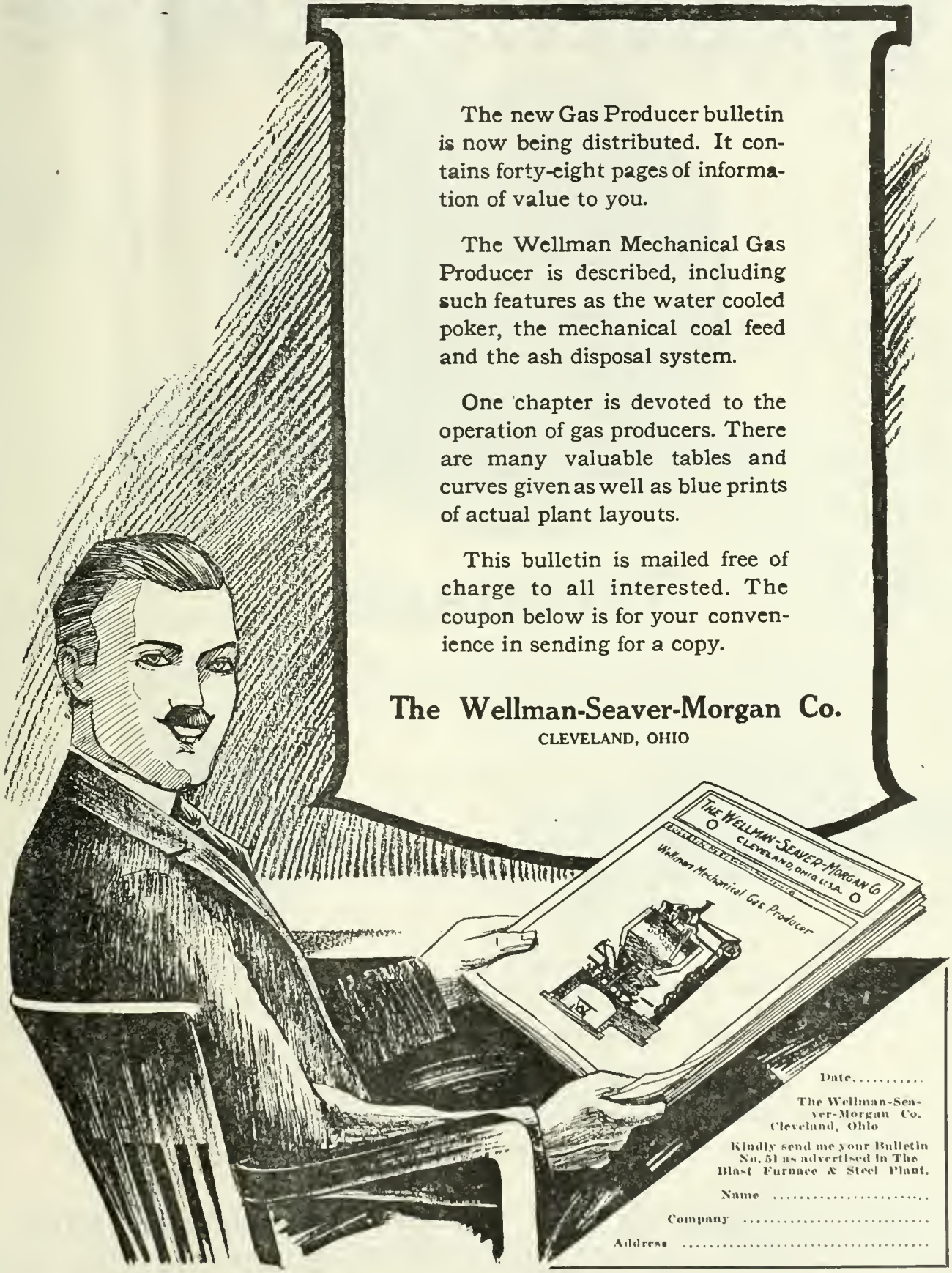

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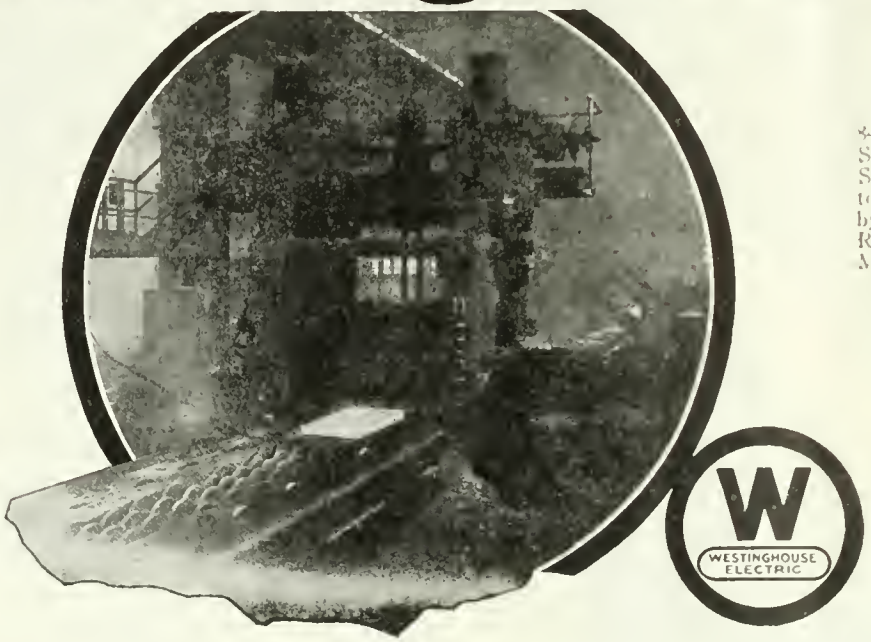

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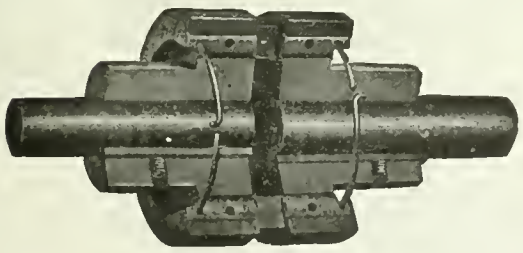

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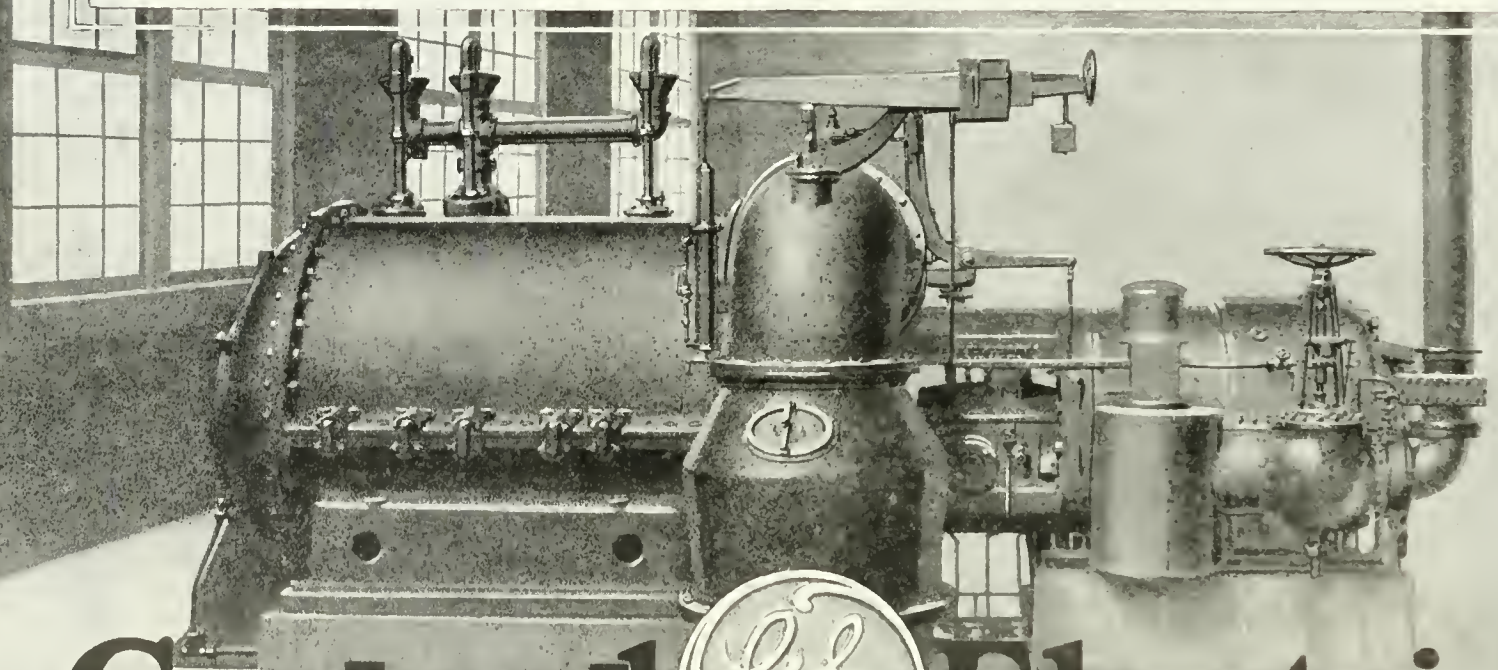

General Electric Company

General Office Schenectady, N.Y.

The Blast Furnace and Steel Plant

The Blast Furnace and Steel Plant

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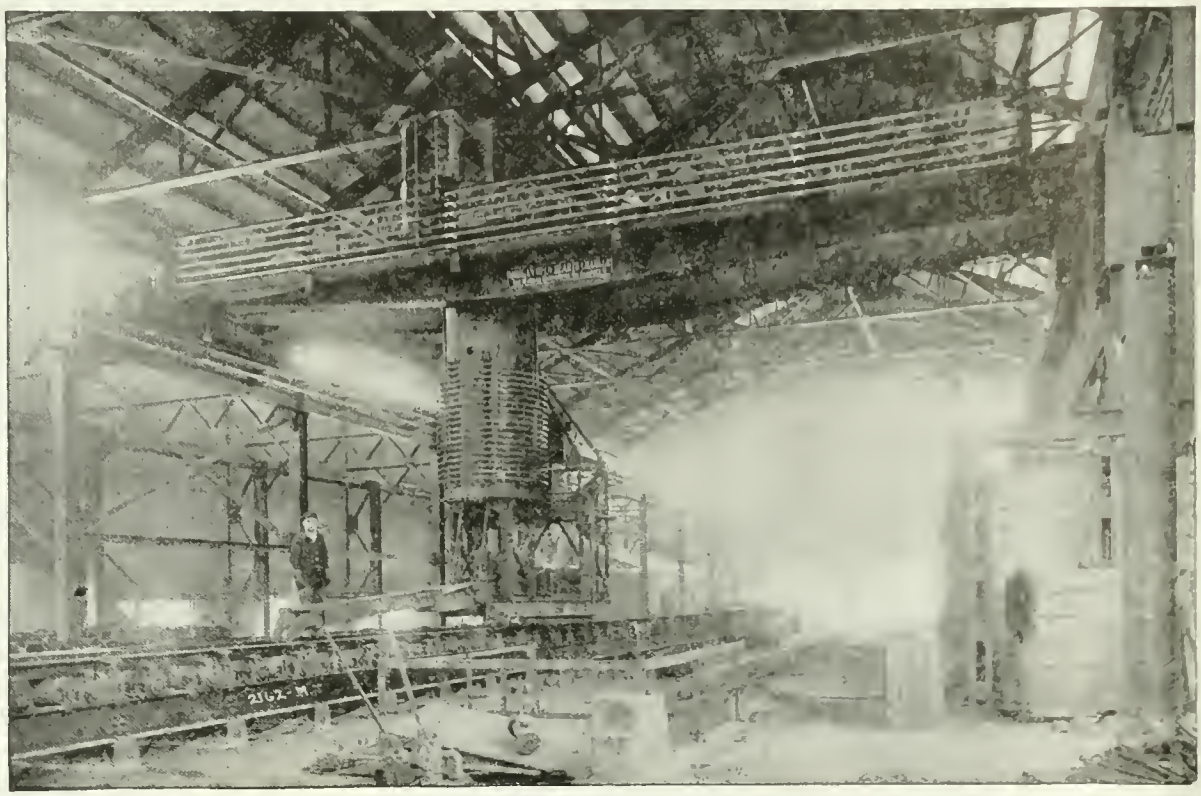

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The Blast Furnace and Steel Plant

VOL. VIII. PITTSBURGH, PA., SEPTEMBER, 1920. No. 9

Manufacturing Seamless Steel Tubes

A General Description of the Manufacture of Seamless Tubing From Solid Round Billets—Cold Drawing of Seamless Steel Tubing—Manufacture of Seamless Steel Tubing from Flat Plates.

THE success of "Shelby" Seamless Steel Tubing is due in a large measure to the excellent qualities of the steel used. This steel, the manufacture of which is controlled entirely by one organization, insuring continual uniformity, is delivered to the heating furnace in blooms of several sizes and weights, some of these being 6, 7, 8 and 10 inches square, about 11 feet long and weighing 1,300 to 3,750 pounds.

After the blooms have been carefully inspected for surface defects, and any irregularities chipped off with pneumatic chisels, they are conveyed by a crane to a furnace room where an electrically operated charging mech-

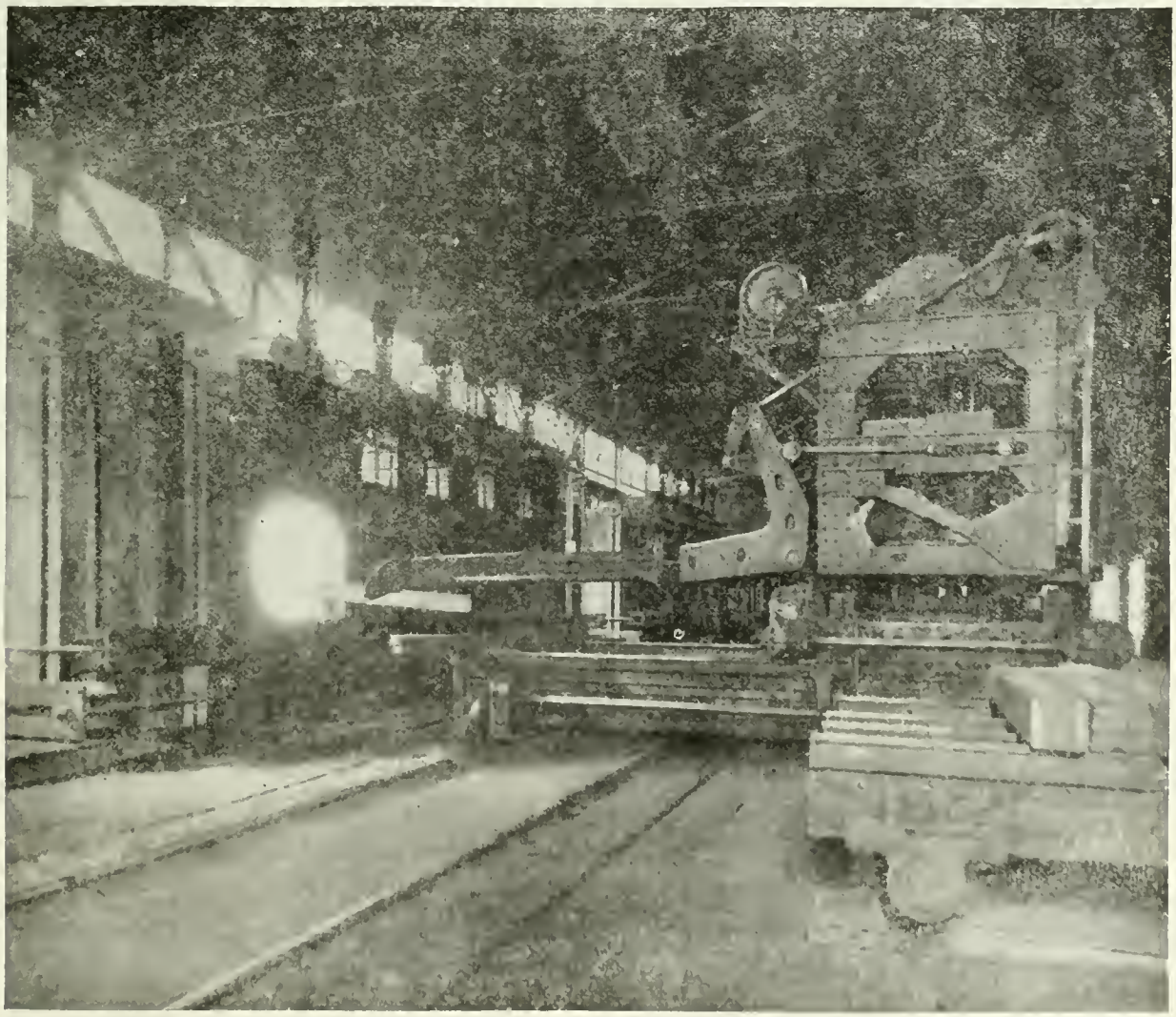


Fig. 1—Charging blooms into bar mill furnace.

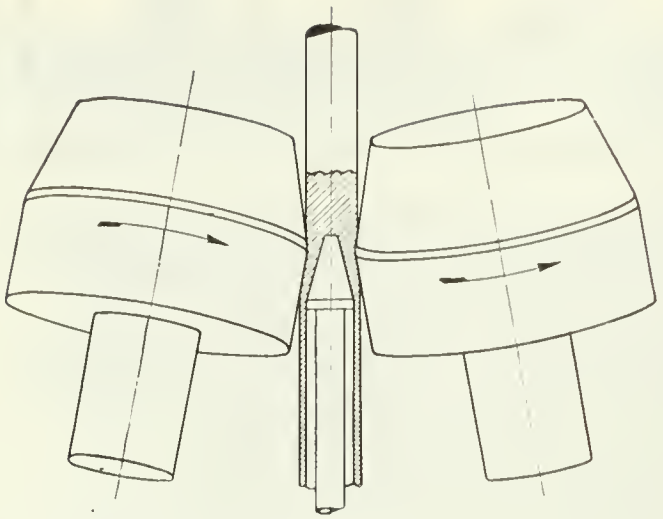


Fig. 2—Diagram of piercing operation.

anism picks them up one by one and places them in a heating furnace.

When the proper temperature for rolling has been reached, the bloom is pulled from the furnace by the long arm of the crane or transfer mechanism and placed upon a small electric buggy; this buggy transfers it to the rolling table of the bar mill where it passes through a series of rolls which changes the square bloom into a round bar of smaller size and greater length. Different sizes of round bars are thus rolled according to the size of tubes required to be made from them; some of the bars are 8 inches in diameter when finished; while others are as small as 3 inches. While still at rolling heat, the round bars are cut to different weights (according to the length and wall thickness of the finished tube) by a circular saw, and centered while still hot. They are then allowed to get cold, after which they are inspected, marked with a die to identify the steel, and sent to the piercing mill.

The bars are now known as billets, or "rounds," and contain just enough metal for making tubes of the desired length, thickness and diameter, and to compensate for normal losses incident to manufacture of the tube.

The first operation in making a seamless tube from

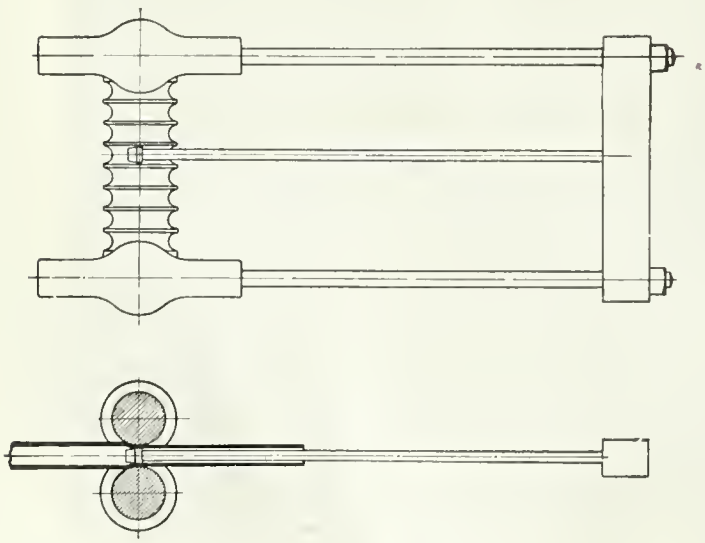


Fig. 3—Diagram of Rolling Operation.

the billets, or "rounds," is known as "centering." In this operation, which is performed by a pneumatically operated machine while the billet is still hot from the rolling mill, an indentation is made in the center of one end of the billet by a punch, in much the same manner as preparation is made for drilling holes in metal by center-punching. The cavity, or countersink (about 1 inch deep) thus produced insures proper starting of the hot billet in the piercing operation, permits insertion of the piercing point at its most effective position in relation to the piercing rolls, and makes for an equalized displacement of metal from the center of the billet.

After the billets have been centered, inspected and marked, they are placed in a heating furnace of special construction. The bottom of the furnace is inclined, and centered billets of the proper length are fed into the upper and cooler end, from which they roll by gravity to the lower end, where the temperature is high enough to render the steel soft and semi-plastic

The piercing mill is located close to the discharging end of this furnace and the billets are fed into it, centered end foremost. The solid billet, almost white hot, is pushed forward until it is caught by the revolving rolls

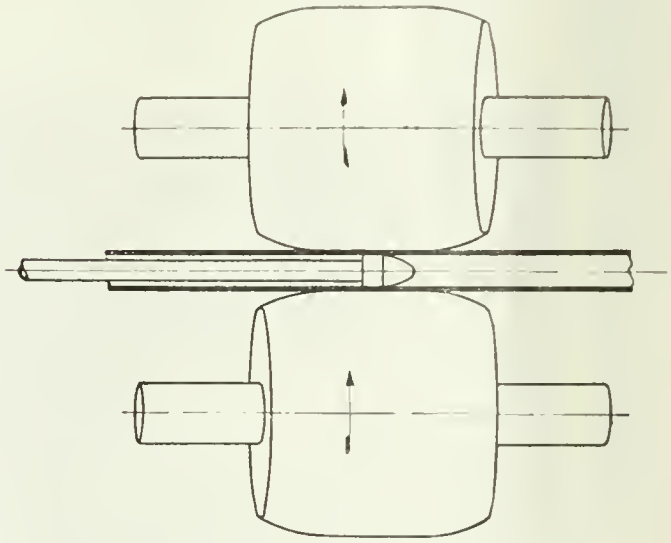


Fig. 4—Diagram of reeling operation.

of the piercing machine which force it over the piercing point of a mandrel. As the billet is forced over this bullet-shaped point by the combined forwarding and rotating action of the heavy revolving rolls, a dull, grinding sound is audible. While enormous force is required to operate the piercing machines, there is nothing spectacular about the operation, nor much suggestion of the enormous power required to displace the metal from the center of the hot billet toward the outside. So powerful are the revolving rolls of the piercing machine and so carefully planned is each part of the massive machinery, that the billet is transformed into a tube with apparently the same freedom as a lump of dough would be manipulated by a pastry cook.

The newly pierced billet is simply a rather rough, thick-walled, seamless tube. It is raw in appearance and not particularly true to size, and it retains the knurl marks of the piercing rolls on its battered surface. But it is positively without seam or weld, the round bar of steel having been pierced quite through its length, as a potter would force a pointed rod through a cylindrical

mass of moist clay. It is short, because of the thickness of its walls, and to change this thickness into length is the next requirement. Accordingly, it is rolled through adjustable rolls and over a mandrel held in the roll groove by a long steel bar where the wall thickness and diameter are reduced, and in this manner it is converted into a longer tube with walls of uniform thickness having a fairly smooth finish.

While still at suitable working temperature, the rolled tube passes on through the reeling machine. This is another form of rolling machine, consisting of two heavy rolls of special design, set with axes askew, which may

rough ends are trimmed from the tubes and the tubes cut to proper length. Any slight straightening necessary is then done, the tubes thoroughly inspected (if boiler tubes, a hydrostatic pressure test is also applied), then stencilled, put in stock or sent to the shipping room.

Tubes which have passed through the operations described up to this point are known as hot finished tubes.

The term "hot finished" is used to distinguish these tubes from hot rolled tubes which are intended for cold drawing to smaller sizes. When tubes are "hot finished" they are ready for use without further treatment in the

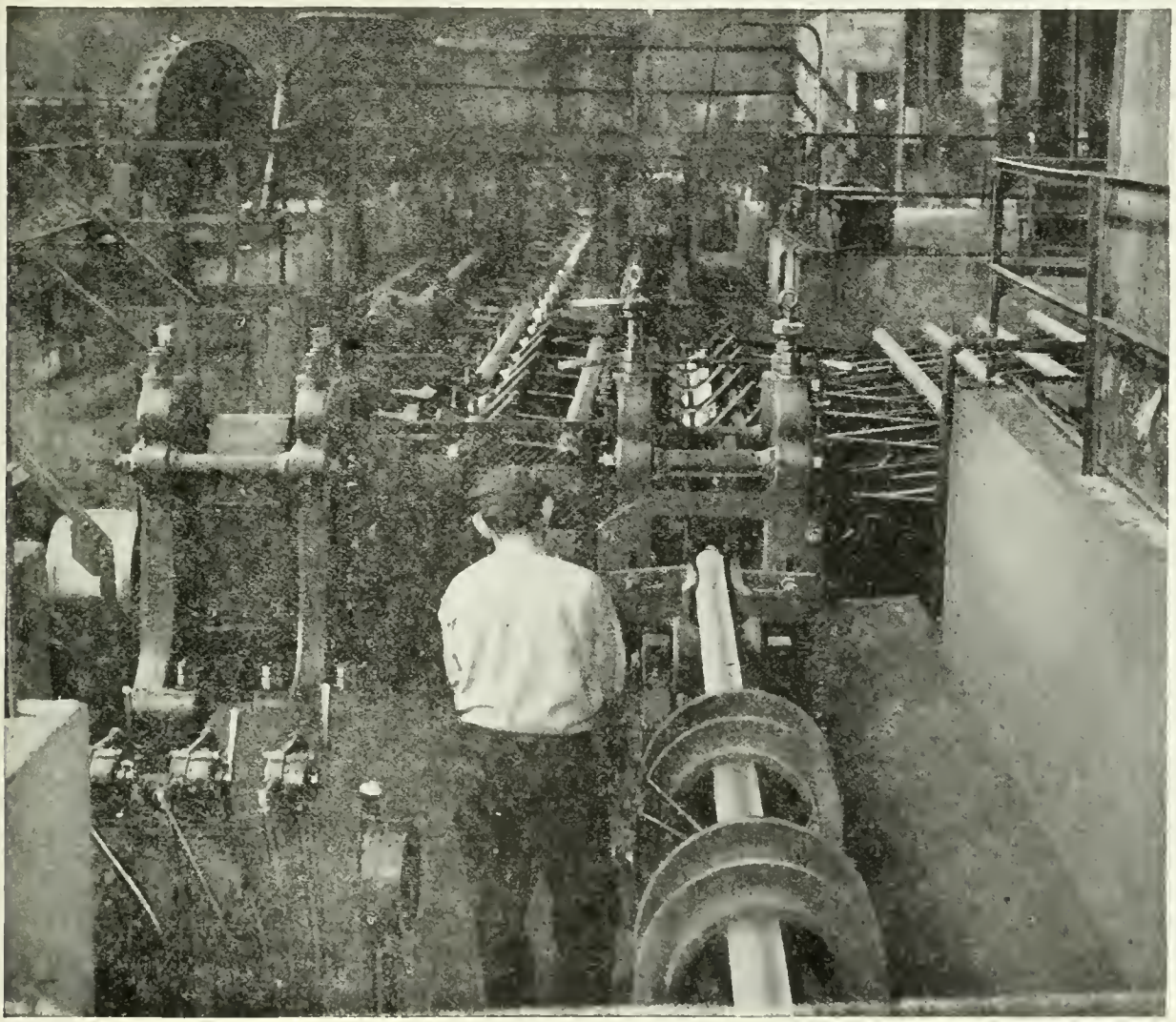


Fig. 5—Reheated tubes passing through sizing rolls.

be adjusted to a thousandth of an inch. As the tubes are fed through these holes, any mill-scale is removed and they are given a smooth, burnished surface, and the outside diameter of the tube is corrected to some extent.

From the reeling machine, the tubes pass to the sizing or finishing rolls, which give the exact outside diameter required.

From the finishing rolls, the tubes travel to an inclined cooling table up which they slowly roll, and after being sorted and inspected are dropped into racks, ready for removal by electric cranes. The electric cranes transfer the hot finished tubes to cutting-off machines where the

mill, and all operations are performed on the tube before it becomes cold, thus differing from the manipulation of cold drawn tubes, which are allowed to become atmospherically cold before reaching the draw benches.

Cold Drawing of Seamless Steel Tubing.

Hot rolled tubes that are to be cold drawn are given the same piercing, rolling, reeling, and sizing operations as tubes that are to be not finished. The first operation preliminary to cold drawing, is pointing the tubes. One end of each tube is heated and then pointed in swaging dies under a power hammer. Pointing the tube furnishes a "bait" which is grasped by the heavy tongs of the draw-

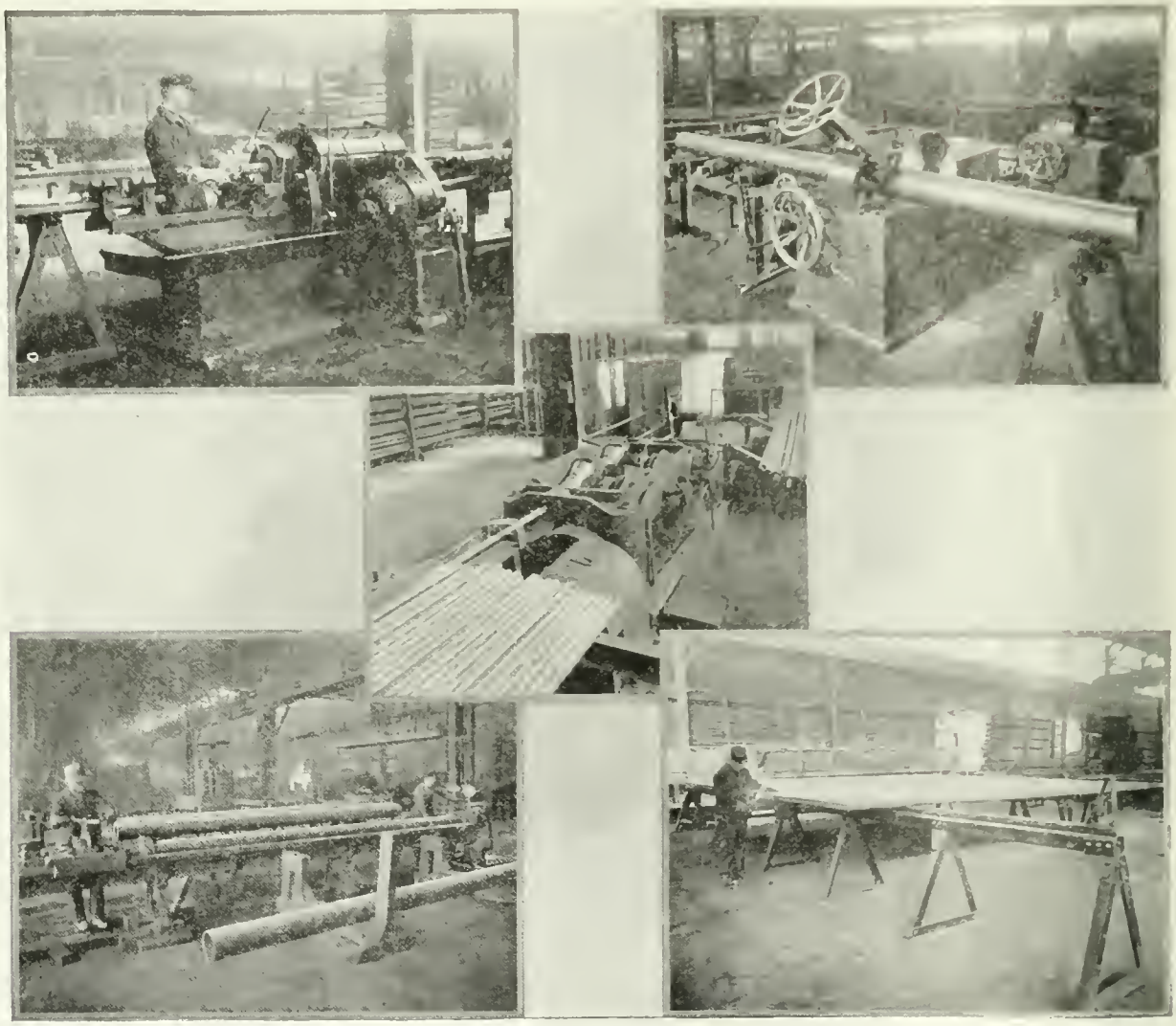
bench in which the tube is to be cold drawn. In this way an even distribution of the pulling force is effected when drawing the tube through the die.

Before tubes can be cold drawn they must be clean and free from mill-scale. They are therefore pickled in an acid bath which is heated and kept in constant agitation by jets of steam.

While the operation of cold drawing is simple in principle, expert mechanical supervision is necessary to secure uniform, accurate results. The operation is practically the same for steel tubes as it is for brass and copper tubes. The apparatus used consists of a heavily constructed steel draw-bench, in the center of which is positioned the die through which the tube is to be drawn. A heavy, square-linked endless chain runs over a wheel located underneath the die, and travels along the top of the bench for a distance of from 15 to 40 feet to a sprocket which is geared to a suitable source of power. The chain returns underneath the draw-bench.

In operation, a hot rolled tube (now perfectly cold) is partially inserted in the die with its pointed end projecting through. A workman slides a mandrel into the tube from the opposite end, and an operator seizes the pointed end of the tube with heavily constructed tongs which run on wheels along the bed of the draw-bench. The tongs have a strong hook that catches on the traveling chain. By a tremendous pulling force the tube is drawn or literally squeezed through the die, or between the die and the mandrel previously inserted. All tubes except those of one-half inch inside diameter and less, and those in which the wall is very heavy, relatively to the diameter, are drawn over mandrels. The mandrel is kept in position by a long bar which goes inside of the tube and holds the mandrel just even with the die while the tube is being drawn. Dies are made from the very best grade of crucible steel, and are machined to the thousandth of an inch, to govern the outside diameter of the tube that is to be drawn. "Shelby" Seamless Steel Tubes are drawn from 2 to 20 times through dies of varying diameter to obtain the required dimensions; some tubes are drawn still more by the manufacturing consumer, and the fact that they retain their uniform qualities through all of this manipulation is an excellent demonstration of the general high quality of the material.

After the tube receives the final pass through the dies, which brings it down to the desired outside diameter and thickness, the point is cut off and the tube passes to the annealing furnaces.



Cutting off crop ends. Hydrostatic test

Straightening hot finished tubes.

Cold swing tubes. Final inspection.

Cold drawing makes the tube hard and brittle, and, therefore, after each cold drawing pass it is necessary to anneal the tube in order to make it soft enough to withstand further drawing. The process of annealing forms scale on the tube and this must be removed by pickling, otherwise the scale would scratch the tube and score the die on subsequent cold drawing passes.

After the last cold drawing operation, the tube is subjected to one of various anneals, according to the use for which it is intended. This anneal may vary from a "light" anneal to remove drawing strains, to a "long" anneal in a closed box "retort anneal," which makes the tubes extremely soft and ductile.

After the required anneal has been given, the cold drawn tube passes to the straightening machines, where any deviations from straightness are corrected. These straightening machines are of different types, some of them based on a planetary system of roll-rotation, others consist of horizontal and vertical rolls together, and still others being nothing more nor less than presses designed for the purpose. In the two first-mentioned types, the straightening of the tube is practically automatic, while the human element enters to some extent in straightening after it leaves the cutting-off machines and has been inspected. The test pressure applied to tubes under 5 inches in diameter is 1,000 pounds per square inch, and to tubes 5 inches in diameter or over, an internal hydrostatic pressure of 800 pounds per square inch, provided the fiber stress corresponding to these pressures does not exceed 16,000 pounds per square inch. In certain cases where the fibre stress is over 16,000 pounds per square inch, tubes of standard thickness over 6 inches in diameter are tested to 500 pounds per square inch at the mill. After the tubes have been fully tested they are marked with a stencil, showing the name of manufacturer, the test pressure used, kind of material of which the tube tubes with the press type of machine. Small tubes are sometimes straightened by hand in a bending rack, the workman's eye and expert judgment being the main factors in securing the result.

After leaving the straightening machine, the tube passes to a cutting-off machine where it is either cut to specified lengths or multiples, or to the best advantage in random lengths. When this has been accomplished, the tube (if for mechanical purposes) is given a final inspection and sent to the stock rack or shipping room.

If the tube is a Seamless Steel Boiler Tube it is given an internal hydrostatic pressure test immediately

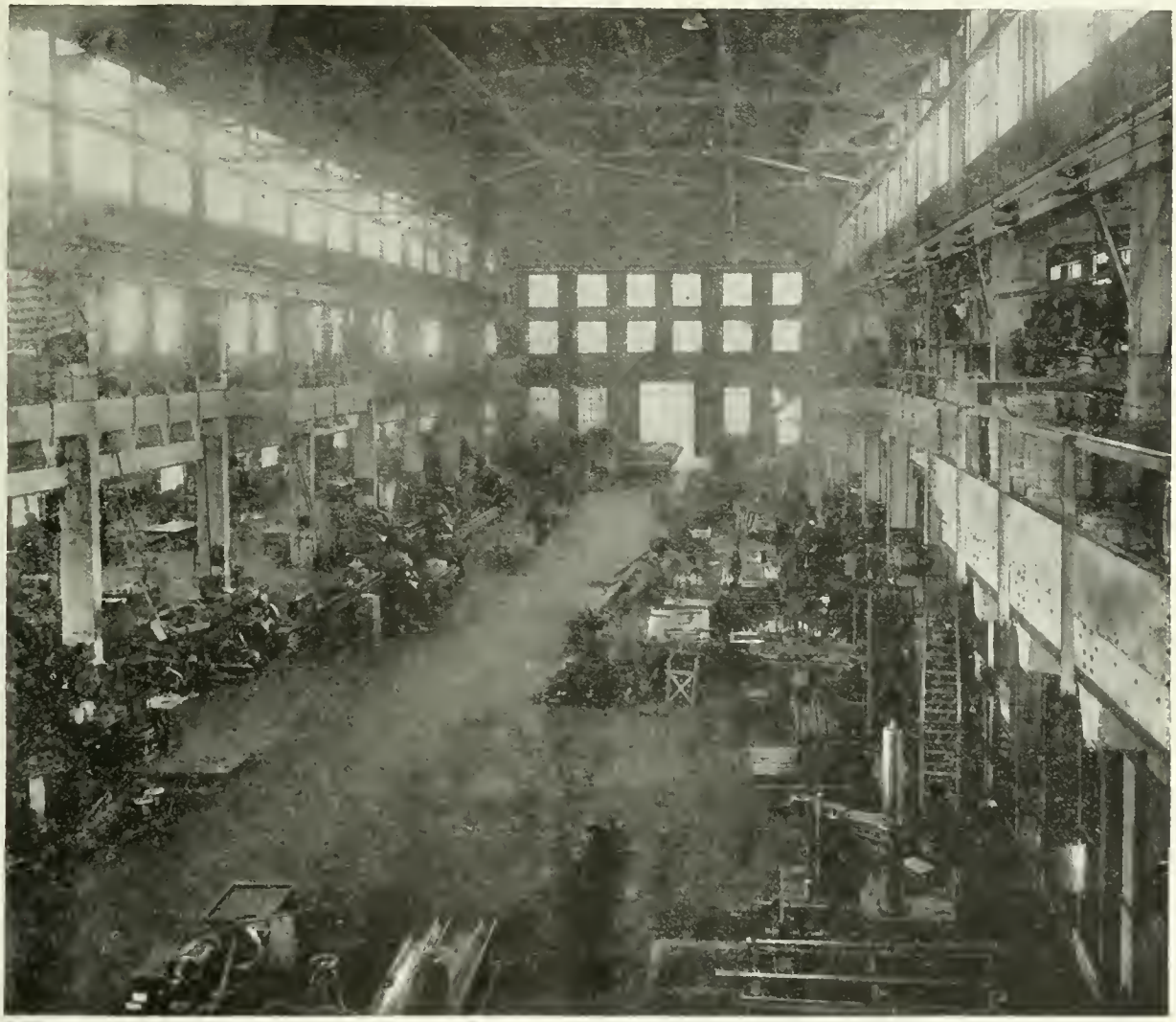


Fig. 7—Machine shops, Elwood works.

is made, and how finished. Tubes intended for mechanical purposes are tested differently than those used for boiler tube purposes. All tubing is subjected to frequent and rigid inspections and testing and it is because of these inspections and other important factors such as high-grade material and the modern manufacturing facilities described, that "Shelby" Seamless Steel Tubes represent the highest standards of accuracy in diameter, gauge, and wall thickness.

Manufacture of Seamless Steel Tubing From Flat Plates.

Seamless Steel Tubes, in diameters up to and including 5½ inches, are made by the piercing process described in the foregoing pages—tubes 5½ inches to 9¼ inches can be made by either the piercing or cupping process—while for tubes larger than 9¼ inches the cupping process is generally employed.

By this cupping process, large, heavy-walled tubes are made from square plates of steel, which are practically the same as would result from the piercing of very large solid billets, if this were feasible.

However, it will be readily comprehended that to obtain a seamless tube, say 20 inches in diameter, from a solid billet of steel, would necessitate rolling and piercing machinery of most gigantic and unwieldy proportions, and to drive such machinery would require tremendous power. But a tube 20 inches in diameter is seldom required in length greater than 10 feet and for such lengths the cupping process can be more economically and advantageously employed.

The first "cupping" process seems to have been patented in England by Remond, in 1851, and was intended for small tubes as well as for those of considerable size, but at the present time the cupping process is used principally in the manufacture of large tubes.

The steel plates from which these larger tubes are made contain the calculated volume of metal required for the finished tube, plus a sufficient amount of compensate for the normal losses in manufacture. They are made from the same grade of steel as are the billets for the smaller sizes, and are delivered to the heating furnace in squares varying in thickness from ⅜ inch to 4 inches, and in size from 2 to 7 feet square.

The square plates are placed in the heating furnace, and after reaching a proper temperature, are withdrawn, the corners sheared off to produce circular plates, or discs, and immediately passed to a hydraulic press where they are punched into rough, shallow cups. The cups are again

Fig. 8—Annealing furnaces where tubes are annealed between bench passes when cold drawing.

heated and punched through a smaller die to elongate, or deepen them and at the same time to reduce the diameter.

After a plate, or disc has been formed into a cup of suitable dimensions, it is reheated and drawn through a series of dies in a horizontal bench. This apparatus consists of a heavy cast steel frame, or body, provided with a powerful hydraulically operated plunger which can operate through the full length of the bench. Punches of various sizes are placed on the end of the plunger, according to the size of tube desired, and dies of successively decreasing diameter are dropped in recesses in the bench frame in positions so that the heated elongated steel cup may be forced through them one after another by the punch.

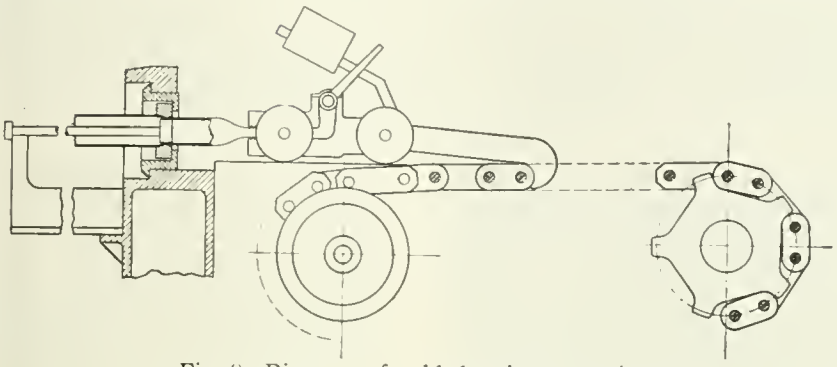
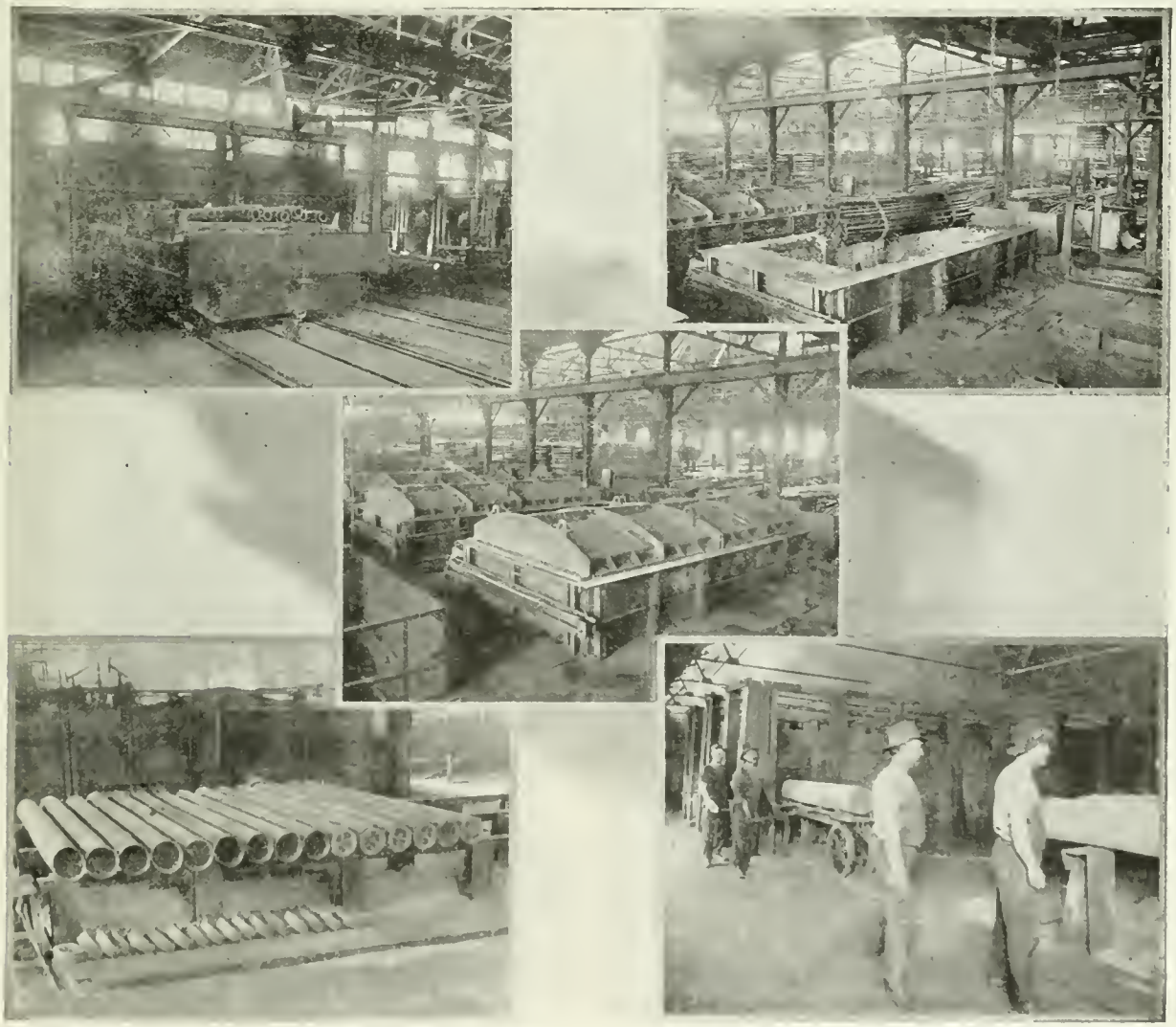


Fig. 9—Diagram of cold drawing operation.

Inasmuch as the reduction of diameter and walls is limited for each heat, a cup may be heated and drawn as many as 12 times before it is a finished tube.

A plate has now passed into tubular form, and the original head, or the bottom of the "cup," forms but a small proportion of it. Subsequent hot drawing operations may be necessary to produce a tube with a smaller diameter, a thinner wall, or a greater length. Finally the head, or closed end of the tube, which remains until the last operation is completed, is cut off, the tube is inspected and tested hydrostatically and the process is finished. If the tube is to be used in making seamless steel cylinders, the head is left on to form the bottom of the cylinder, or a special type of head can be made by spinning or welding.



Moveable bottom furnace (bottom out) Retort annealing for small tubes

Moveable top Furnace (top off)

Moveable top furnace (top off) Charging retort

A. I. & S. E. E. this Month

Fourteenth Annual Convention of Iron and Steel Electrical Engineers to Be Held at Hotel Pennsylvania, New York City, September 20 to 24.

PREPARATIONS are now being made for the Fourteenth Annual Convention of the Association of Iron and Steel Electrical Engineers, which is to be held in the Hotel Pennsylvania, New York City, September 20 to 24, 1920. It is estimated that over 1,000 persons will attend the meetings. All the principle centers of the steel industry are to be represented: Pittsburgh, Chicago, Cleveland, Buffalo, Philadelphia and Birmingham will send large delegations. In addition a large foreign representation is expected.

The meeting will convene promptly at 10 a. m. Monday, September 20, and will continue through until Friday afternoon. Twelve technical papers, prepared by some of the foremost electrical engineers of the steel industry will be presented during the convention.

The annual banquet will be held in the Pennsylvania Hotel on Wednesday evening at 7 o'clock. The banquet is always one of the features of the convention.

Another most important feature will be the exhibits. Practically all the representative electrical manufacturers of the country have arranged for spaces, and their booths will undoubtedly prove most interesting.

Among the booth holders are the following:

	Booth No.
Thermoid Rubber Company	1
Electric Dynamic Company	2
Electric Arc Cutting and Welding Company	3
Shepard Electric Crane and Hoist Company	4
Irving Iron Works	5
Union Electric Company	9
Electric Service Supplies Company	10-11
Rowan Controller Company	12
Ohio Wilson Welder and Repair Company	13
Corliss Carbon Company	14
Allen Bradley Company	15
Westinghouse Electric and Mfg. Company	16-17
[illegible]	18
Keystone Lubricating Company	22
Blast Furnace and Steel Plant	23
Doub'eday-Hill Electric Company	24
Standard Underground Cable Company	25
Thompson Electric Company	26
Benjamin Electric Manufacturing Company	27-28
National Lamp Works of General Electric Company	29-30
Electric Controller and Manufacturing Company	31
V. V. Fittings Company	32-33
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"Power Transmission for Industrial Plants"—D. M. Petty.

"Centralized Turbine Generating Stations for Steel Mills" T. E. Keating.

"Some Considerations in the Determination of Auxiliary Drives"—Gordon Fox.

"Report of Electrical Development Committee for 1920" E. S. Jefferies, Chairman.

"Relation of Standardization in Electrical Equipment to Safety"—Walter Greenwood.

"Report of Electric Furnace Committee for 1920" E. T. Moore, Chairman.

"Standardization Committee Report" W. T. Snyder, Chairman.

"Practical Education of Steel Mill Electricians" Educational Committee.

"Underground Transmission"—A. L. Freret.

"Current Limit Reactance"—R. H. Keil.

New Blast Furnace Built in China

The Yangtse Engineering Works, Ltd., Have Completed a New 100-Ton Blast Furnace in Hankow, China—Many Prominent Men Were in Attendance at the Opening Ceremonies.

THE opening ceremony of the blast furnace of the Yangtse Engineering Works took place on Saturday, June 26, 1920, in the afternoon, under the auspices of ideal weather in spite of the threatening showers of rain in the morning. There were over 200 guests present, among whom were Han Kwong Tsao, Chief of the Civil Service and representing the Tuchun and the Civil Governor of hte Province, the foreign consuls and prominent Chinese and foreign business men, as also the directors and engineers of the railways, and superintendents of the Hanyang Iron Works and Arsenal. William Pigott, president of the Pacific Coast Steel Corporatoin, who arrived here in the morning, on a tour of investigation, evinced his interest in the enterprise by his presence also.

Shortly after 3 o'clock launches and tugs took the guests down from the Racine Ackerman Jetty to the site of the works, in Seven Mile Creek. On arrival, they were received by Wong Kok Shan, representing the directors of the company and by Mr. Wong Kwong, the general manager, who showed them round the blast furnace plant. They were given an opportunity of seeing the tapping of the iron, which was arranged to take place about that time.

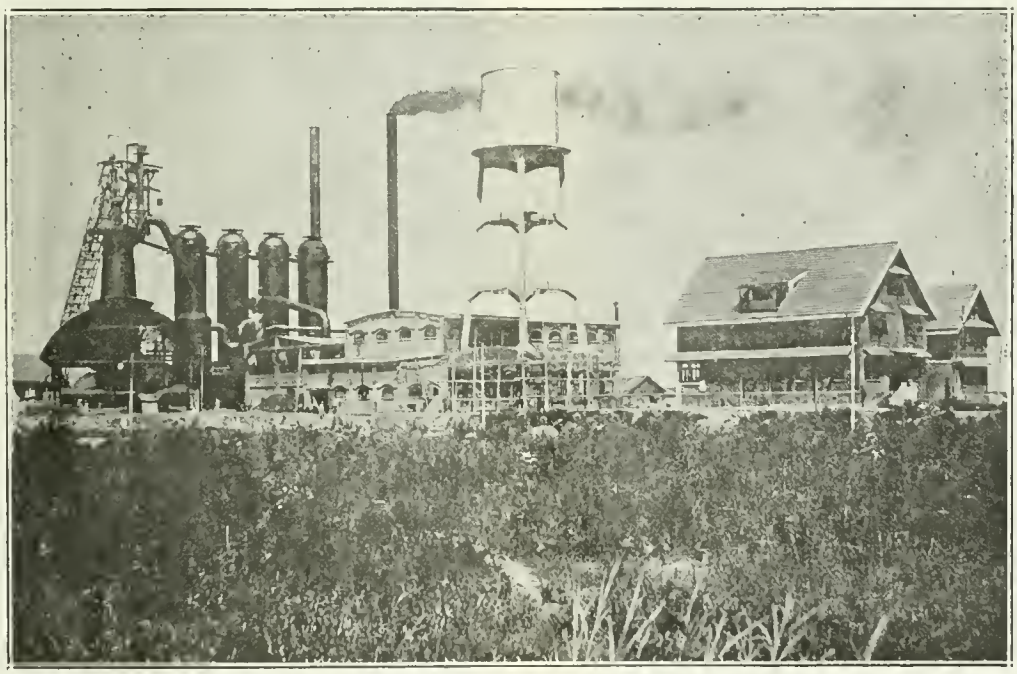


Fig. 1—General view of new plant.

The guests were then led to a spacious matshed decorated with flags and buntings, in which refreshments were served.

Wong Kog Shan welcomed the guests in a Chinese address, which was replied to by Mr. Han on behalf of the Tuchun and Civil Governor.

Mr. Wong Kwong then addressed the meeting in English as follows:

"On behalf of the directors of the company, I thank you for the interest you have evinced in our works by your presence today at the opening ceremony of our blast furnace, which was blown in on May 22, last. It has often been commented on that China, with her vast population and territory, should do more in the development of her iron industry, which is the backbone of all industries, than she has done in the past, and acting on this principle, we have been bold enough to make this modest attempt in adding one more furnace in China proper to those already in existence in Hanyang, so long the solitary beacon in this realm of industrial possibilities. Our aim is not one of rivalry with others but of mutual help and coöperation, as we believe that there is room for more.

"The plant which you see today is modern in every respect, and with the exception of the furnace, the hot stoves and dust catcher with their connections, the designs of which were supplied by Perin and Marshall, of New York, the whole plant and equipment were designed by the engineering staff of the Yangtse Engineering Works, and the materials for the whole plant, excepting pumps and three ready made engines, were fabricated and erected by us. Owing to the considerable delay attending the acquirement of the required land, the foundation work was not commenced till the latter part of January, 1919, and the furnace would have been completed earlier, had it not been for the one or two months of flood we had last year, and the month of snowy weather we had in the early part of this year.

"The furnace is designed to produce 100 tons of sand cast pig iron per day. It is supported by six cast iron columns, has six tuyeres, and is lined with firebricks purchased from the Kailan Mining Administration, Tientsin.

"We may be permitted to say that having overcome the initial difficulties in the fabrication and construction of such a plant in China, to the extent of even making certain alterations in the original to suit local conditions, we feel confident of being able to execute similar orders for other iron and steel works in the Far East. However, the future success of our works depends upon your good will and support, which we wish to bespeak.

"Our honored guests, I thank you most heartily for the honor you have done us by taking part in our celebration today, and now let us take this opportunity of drinking to the health of our distinguished guests."

C. C. A. Kirke, acting British Consul in Hankow, replying on behalf of the foreign guests, congratulated the works on the success they had achieved, and was followed by L. E. Gale, who proposed drinking to the success and prosperity of the Yangtse Engineering Works.

The furnace is designed to produce 100 tons of sand cast pig iron per day. It is supported by six

cast iron columns, has six tuyeres, and is lined with firebricks purchased from the Kailan Mining Administration, Tientsin. The cast house is about 50 feet span and 100 feet long with steel columns and iron roof.

Bosh cooling is effected by sprays held on the steel plate jacket by plate strips. Also in addition there is one row of copper bosh plates immediately above the tuyere line. There is no cooling above the mantel but a permanent spray pipe is installed on the shell to take care of any possible hot spots that may be developed in the future.

The furnace top is of the double bell stationary

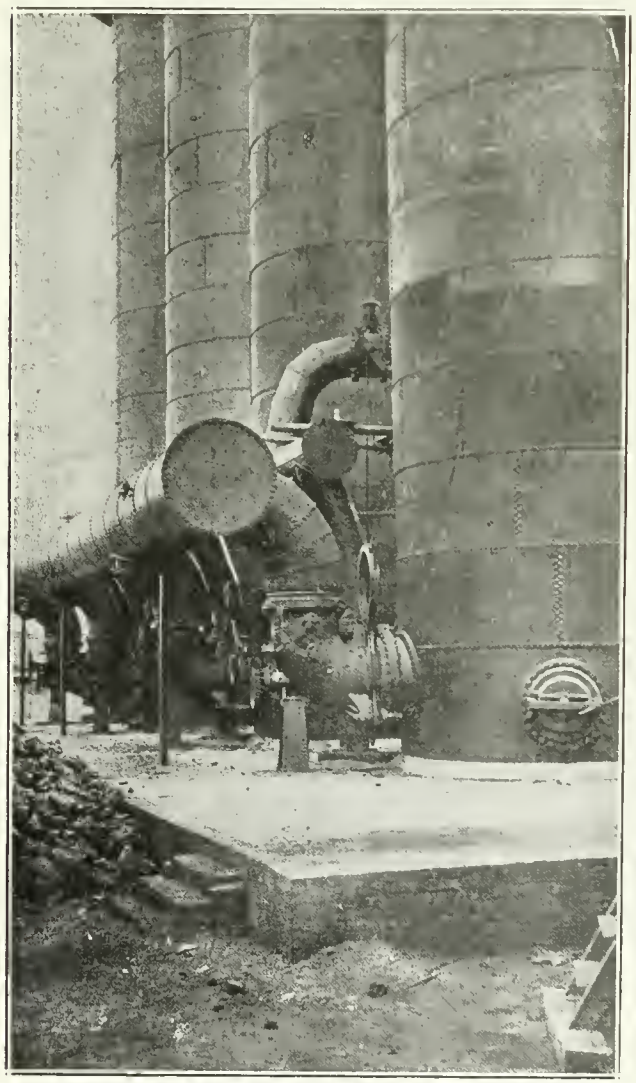


Fig. 2—View of hot stoves and chimney valves.

type and is served by a single ship counter balance weight through a balancing tower at the bottom near the hoisting engine. There are two sets of horizontal hoisting engines (one for spare) each with double high pressure cylinders 12 inch diameter by 20 inch strike designed and built by the Yangtse Engineering Works.

There are one primary dust catcher of ordinary type and one centrifugal whirler for cleaning gas for stoves and boilers.

Filling on the bottom is by means of buggies for ore, limestone and coke. Cast iron plates form the floor of the stock house.

The blowing equipment consists of two horizontal connected cross compound engines and one tandem compound engine. As during the time of war, it was impossible to purchase any blowing engines, the steam end of these engines was purchased from stock abroad, while the air end was designed and made in the Yangtse Engineering Works here, being equipped with plate valves of the Allis Chalmers type.

Air for blowing engines is taken through two cylindrical containers arranged and cooled similar to a surface condenser with air condnit to the three blowing engines. This is calculated to precipitate moisture and afford a drier blast especially in the hot summer when the atmosphere is high in moisture.

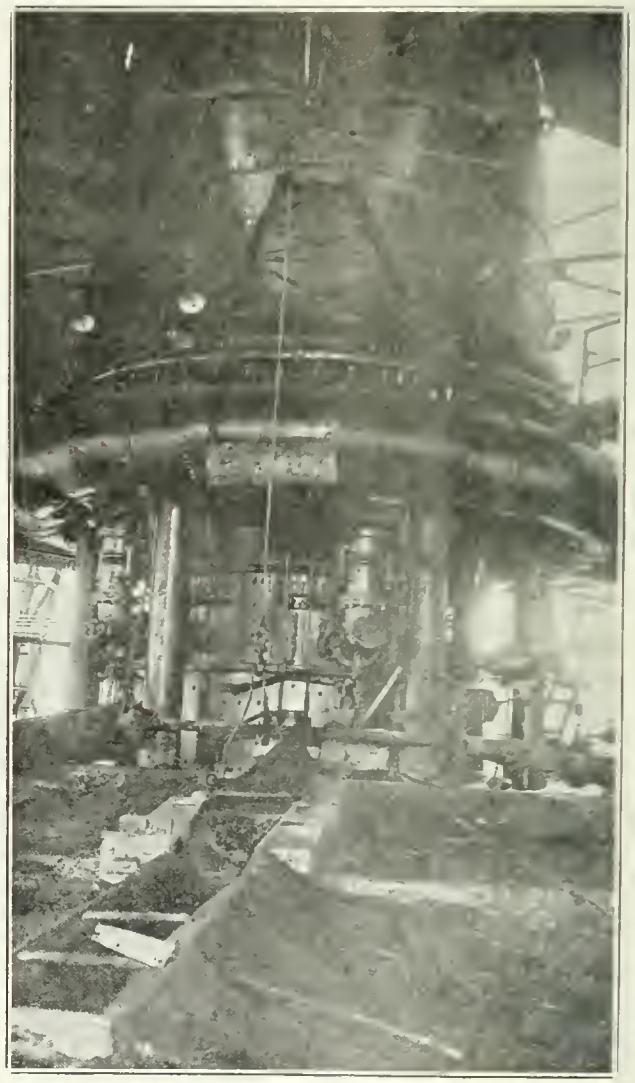


Fig. 3—View of furnace proper.

Two surface condensers, each about 1,200 square feet condensing surface and calculated to give 25 inches of vacuum, have been installed.

In the boiler house are four boilers of the water-tube type, each of 1,500 square feet of heating surface and 150 pounds working pressure, provision being made for two more. They were designed and built by the Yangtse Engineering Works, as were also the Peaton type gas burners. Condensate from the condensers is filtered and used for boiler feed water

with provision made for "made up" water from the water tower. There are two Weir pumps for feeding boilers and two horizontal Worthington pumps for general and fire services. The latter have connections for feeding boilers in case of need, and for pumping direct to furnace bosh and spray cooling and cast house, so that in case it is found necessary to cut off water supply from the tower, these two pumps will be sufficient to keep the furnace going.

Boiler feed water is heated by exhaust steam from the service pump.

The main water supply flows from a large settling pond at the back of the Yangtse Engineering Works by gravity through an 18-inch cement pipe line and is pumped to the water tower by two horizontal steam pumps. Either one of the above two pumps is calculated to furnish sufficient water supply, the other being a spare.

All discharge water from the condensers, stoves, furnace, etc., is returned through deep drains back to the setting pond or to a cooling pond near the water tower and is used over again.

Ample filters have been installed to insure clean water for all purposes.

The water tower, which is of concrete reinforced, is 115 feet over-all, and has a capacity of 80,000 gallons, sufficient for future plant extensions.

The handling of raw materials from the bund to stockyard is rendered exceedingly difficult, by reason of the difference of 45 to 50 feet between high and low water in the Yangtse River. While at present manual labor is employed as a temporary measure, this condition will be taken care of by the installation of rope haulage electrically operated.

A steam generating set is on the way coming out from England, and will be installed in the main engine house. This equipment is to run on steam from the main boiler house and will furnish power for the whole works, allowing the present generator equipment to be held in reserve.

The buildings are: A three-story brick building for combined purpose of office, laboratory and living quarters.

A blowing engine house of brick and reinforced concrete roof 50x90 feet, equipped with a 10-ton overhead traveling crane.

The condensers building at the southeast end of the blowing house, separated by a curtain wall, being built also of red brick with reinforced concrete roof.

A boiler house of red brick and reinforced concrete roof 40x95 feet.

A hoist house of brick and cement face and red tiled roofing.

A haulage house near the shore of the same construction.

Other suitable buildings for housing coolies, workmen and for men around the furnace are also installed.

The Acid Bessemer Process

Description of Process in Which the Pig Iron Is First Desiliconized and Decarburized in Acid Bessemer Converters and Then Dephosphorized in Basic Open-Hearth Furnaces.

By RICHARD S. McCAFFERY,
Professor of Metallurgy, University of Wisconsin.

THIS paper considers certain aspects of the acid Bessemer process, particularly in its relation to the duplex process—that combination in which the pig iron is first desiliconized and decarbonized in acid Bessemer converters and then dephosphorized in basic open hearth furnaces. The acid Bessemer process employs an acid-lined converter and produces an acid slag. The blow is usually thought to eliminate the silicon and manganese as oxides and then to burn off the carbon as carbon monoxide. On account, however, of the relatively large amount of metallic iron present in the converter, compared with the relatively small amount of the impurities it is desired to oxidize, the first reaction in the converter probably is the formation of iron oxide, which dissolves in the bath and acts as an oxygen carrier for the silicon and carbon. As soon as iron oxide is dissolved throughout the bath, the oxidation of silicon commences; but in the early stages of the blow the mass law would indicate that iron oxide must form first, and this oxide probably increases up to some saturation point. The molten metal in the converter from the early stages of the blow right through to its completion remains basic, while the slag produced is siliceous. This fact is shown by the corrosion of the acid bottom and the tuyeres, which is greatest at the tuyere orifice where oxidation is most active and where there is the most iron oxide.

Why does this acid bottom corrode? Because it is attacked by a base. The thought, therefore, suggests itself, why not make the bottoms of basic or neutral material? As the converter slag is acid, those parts of the converter coming in contact with the slag should be acid; but those parts of the converter that are in contact with the molten metal saturated with metallic oxides should be basic or neutral. Bessemer operators have for some time tacitly admitted this condition, for the blast pressures have steadily increased with the object of keeping the metal in suspension, and so preventing bottom corrosion; if the molten metal were not basic, it would not attack an acid bottom. In addition, the tuyeres are bunched together at the middle of the bottom and a clear space is left around the outside of the bottom; if tuyeres are placed too near the side walls the wall corrosion increases. If the increase of blast pressure in Bessemer converters was for the sole purpose of hastening the blow by getting more oxygen into the converter in

Abstract of paper presented before the American Institute of Mining and Metallurgical Engineers.

the same time, the number of tuyeres might have been increased, thus increasing the volume of air and decreasing the blast pressure. It is not desirable though to follow this procedure, because the additional tuyeres can be provided only by placing them near the side walls, which results in increased lining costs.

In a normal blow, the carbon stage begins after the oxidation of the silicon, the carbon burning largely to carbon monoxide; it thus does not generate sufficient heat to raise the temperature of the bath during the latter part of the blow; the great rise in bath temperature takes place in the early stage when the silicon is burning. Many converters, though, particularly those of larger capacity, do not blow a charge in this way; they show a temperature rise during the latter part of the blow, the carbon being burned to dioxide instead of to monoxide, with the resulting liberation of 97,000 calories instead of 29,000 calories. As a matter of fact, many blows that are not initially of too high silicon contents are finished at excessively high temperatures, in some cases running up to 1,800 degrees C. Although the bad effect of this practice is known and attempts are made to lower the final temperature by the addition of scrap to the converter or by the introduction of steam in the air blast, the best method of lowering this temperature, by burning the carbon to monoxide, which also decreases by one-half the power consumption during the carbon stage of the blow, is not used because it is necessary to keep the metal charge away from the converter bottom. By following the present practice, the direct bottom expense may be reduced seemingly, by employing a high blast pressure, but the power cost is greatly increased and the temperature of the finished blown metal is very high; or if the finishing temperature is kept down to the proper point, there is the extra expense of scrapping or of steaming. It does not seem right to charge scrap in a process that has as one of its principal objects the production of scrap, or to expend energy for excess air in order to turn carbon to dioxide when the extra amount of air will be furnished by the atmosphere at the converter mouth. By this plan a vicious cycle is in operation: more energy is employed for blowing in more air, which produces more heat, which requires more energy, in the form of steam, to lower the temperature. With the use of basic or neutral bottoms, blast pressure may be reduced and the tuyere area increased because the basic charge will not corrode bottoms of this character.

The author has already pointed out the possibilities of decreasing the time of blow and decreasing the power consumption with the use of a greater number of tuyeres and lower blast pressure; and Table 1 summarizes the data obtained in a test of a 23-tuyere bottom compared with a bottom designed by the writer containing 35 tuyeres.

Table 1—Results Obtained by Increasing Number of Tuyeres and Decreasing Blast Pressure.

	Old-style Bottom	New-style Bottom
Number of tuyere blocks, each containing twelve 5/8-inch tuyeres	23	35
Weight mixer metal, pound	47,000	50,000
Blast pressure at engine, lb. per sq. in.	28	22
Total engine revolutions per blow	589	443
Time of blow, minute	14	10 1/3
Comparison of time, per cent	100	69
Comparison of power, per cent	100	60

In the open hearth stage of the duplex process, the temperature of the open-hearth bath is an important factor if the dephosphorizing operation is to be successfully carried out, also the temperature of the blown metal passing from the converters to the open hearth is of great importance. To obtain maximum capacity in the open hearth, just as soon as it is ready for the blown metal, the blown metal from the converter should be ready to be poured in; and when the kicker charge is introduced, the bath should be at the proper temperature for the reactions to take place in the proper order. It should not be necessary to raise or lower the temperature of the heat very much. If the temperature of the molten bath in the open hearth is too high, the carbon is burned off first and after nearly all of it has been eliminated the phosphorus is oxidized and slagged. If the bath temperature is correct, the phosphorus reaction takes place first and the heat is finally worked down to the desired carbon content. Carbon is much more active in taking oxygen out of the molten metal than is phosphorus, with the result that when the process is carried out at the proper temperature and the heat is finished on carbon, the steel produced is much less likely to contain oxygen than when the heat is finished on phosphorus. The importance of this point, with respect to the Bessemer stage, is that under certain conditions, already pointed out, the converters may furnish blown metal at an excessively high temperature which may be poured into an open hearth that, for various reasons, may be at a higher temperature than normal, with the result that the order of reactions in the open hearth is reversed and the open hearth product may contain oxygen.

When running down at the end on phosphorus in this way, there is a twofold danger. If oxygen additions are made for the purpose of getting out the phosphorus, there is a chance that the steel will carry oxygen, although it may be thoroughly dephosphorized; whereas if there is not sufficient oxygen-carrying material charged to eliminate the phosphorus, the metal may not contain oxygen but it will not be dephosphorized. The alternatives then, when an open hearth bath is finished on phosphorus, are that the metal either will be oxidized or the phosphorus will not be eliminated, whereas, if the order of reaction were changed and the phosphorus removed first and the carbon taken out at the end, the carbon would protect the metal from oxidation after dephosphorization and good steel would be produced.

It is not claimed that this happens in every open hearth heat, but it does happen in some. This sequence of happenings can be avoided and the possibility of oxygen-carrying steel being made will be cut down to a minimum if excessive blast pressures are avoided. This can only be done economically, in the opinion of the writer, if basic or neutral converter bottoms are employed. The use of these bottoms will avoid the high blast pressures and cut down the power cost by burning the carbon to monoxide. In accomplishing both of these, the production of overheated blown metal will be minimized and the possibility of producing oxidized steel will be very slight.

EDITOR'S NOTE—Henry D. Hibbard, one of the country's foremost metallurgists, and who writes exclusive articles for THE BLAST FURNACE AND STEEL PLANT, is spending some time abroad visiting the steel plants there. He will have some interesting data for our readers on his return.

New Burner for Blast Furnace Gas

Description of Steinbart Burner as Used in Blast Furnaces at the Lorain Works of the National Tube Company—Automatically Regulates the Air for the Burner.

By DONALD N. WATKINS.

ALFRED STEINBART, of the National Tube Company has designed a new gas burner which has been used successfully at the Lorain Works of The National Tube Company for the past several years. The main features of the burner are that they take the regulation of the air at the blast furnace boilers and stove burners entirely out of the hands of the fireman and stove tender. A combustion system is used which automatically regulates the air supply so that 0.7 of a cubic foot of air is supplied to the burner for each one cubic foot of blast furnace gas, this being the amount required for the best combustion. The only regulation which the fireman is required to perform, is to turn on the needed amount of gas; the air butterfly opens and closes automatically.

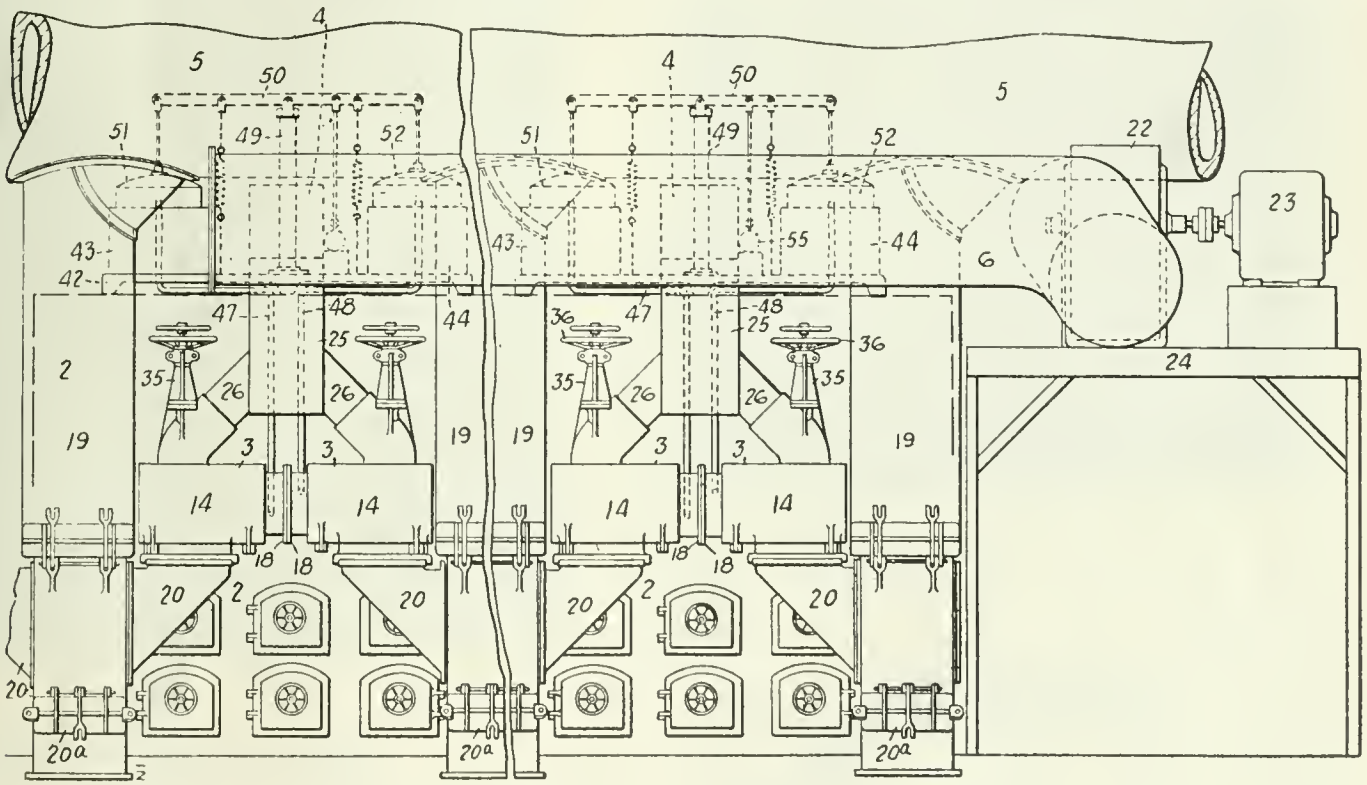


Fig. 1.

The principle of the burner is quite simple. It is provided with a chamber into which the gas is admitted under the control of a hand valve; from this chamber, the gas flows through an orifice into the combustion chamber. Adjoining this gas chamber is an air chamber which is supplied with air under pressure by a fan. From this air chamber the air also flows through an orifice into the combustion chamber. The areas of the gas orifice and air orifice have a proportion of 1 to 0.7. Between the fan and the air chamber is a butterfly valve operated by a regulator under control of the pressure in the gas chamber which regulates the flow of air to the air chamber so that the pressure in the air chamber is always the same as the pressure in the gas chamber. As a result of this arrangement, seven-tenths cubic feet of air enter into combustion with one cubic foot of gas. This proportion is always the same, if the gas pressure is high or low, if the gas valve is wide open or nearly closed, if the pressure in the combustion chamber is negative or positive.

Figs. 1 to 8 illustrate the construction of the boiler burners as applied to a battery of Cahall boilers. These boilers are 250 hp each. Referring to Fig. 1, the gas is supplied to the boilers by the gas main (5) and brought to the burners (14) by the down-legs (19) of which there is one between each two boilers. The air is furnished by the fan (22) which is driven by the constant speed motor (23). The fan discharges into the air header (6) which runs parallel to the gas main in front of all the boilers. In front of each boiler there is a branch (25) leading down from the air header to the two burners which supply the boiler. The boilers are equipped with dutch ovens and on these the regulators (4) are placed, one for each boiler. The hand wheels (36) operate the gas valves (30). These are shown in Fig. 2. The burners are in the shape of a square box. This is divided by a horizontal partition (11) into two chambers, the upper one (13) receives the air and the lower one (12) the gas. Referring now to Fig. 3. From the air chamber

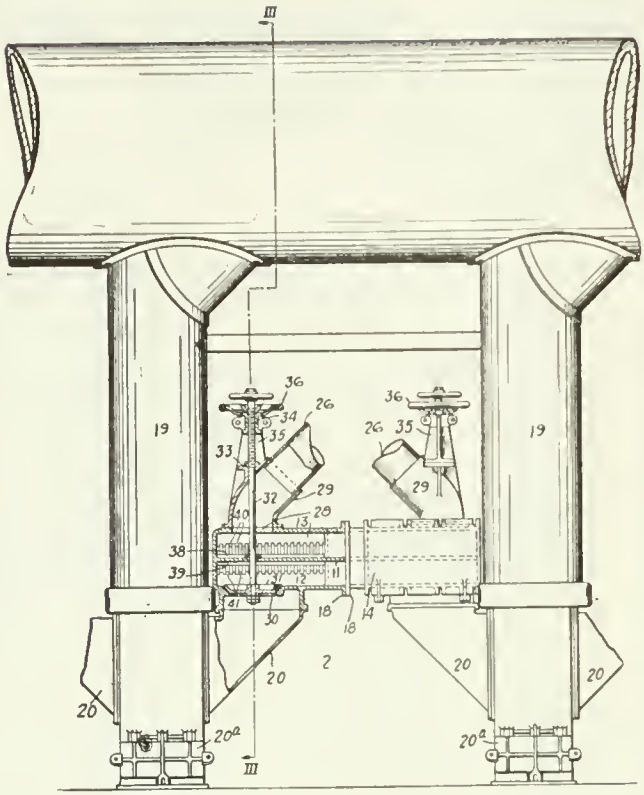


Fig. 2.

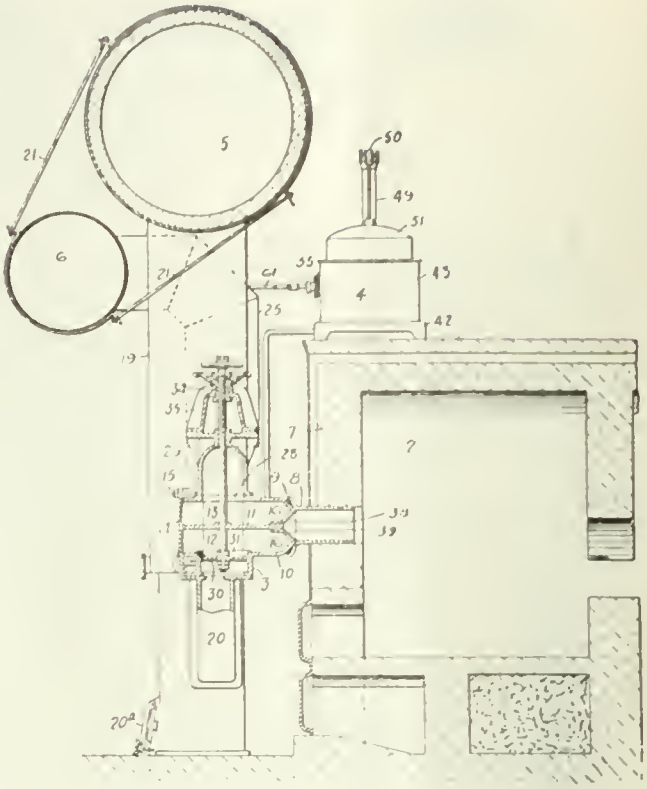


Fig. 3.

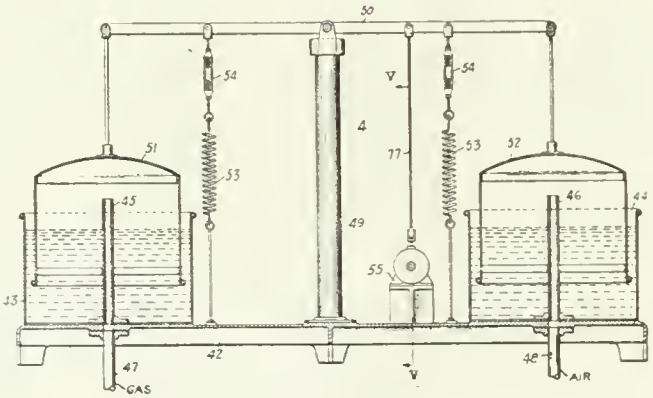


Fig. 4.

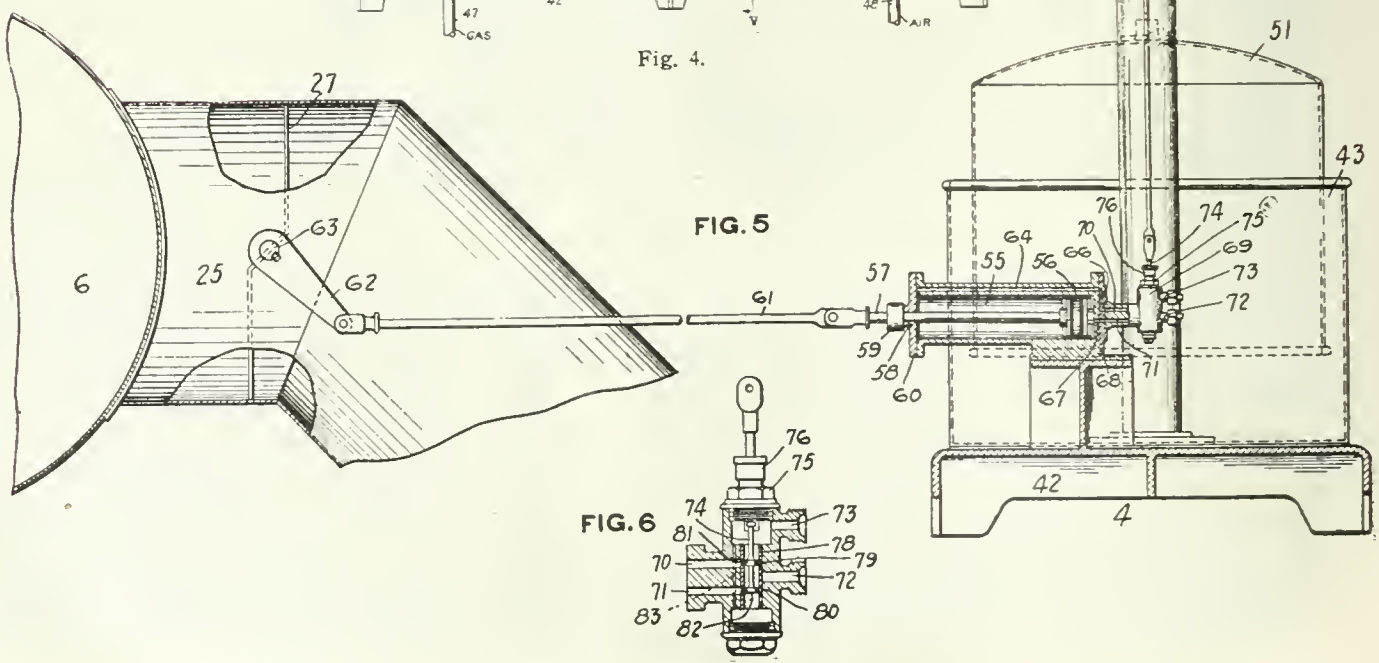


FIG. 5

FIG. 6

there is an outlet into the combustion chamber (2) and adjoining there is another outlet from the gas chamber into the combustion chamber. These outlets are about 2½ feet long and 6 inches wide and in each of these is placed a comb (38 and 39 respectively). These combs have their teeth set so that those of the air comb are staggered in relation to those of the gas comb. The teeth of the air comb form an angle of 90 degrees with the teeth of the gas comb. The air flowing through the air comb therefore cuts under an angle of 90 degrees into the gas flowing from the gas comb, causing intimate mixture. In Fig. 2 these combs are shown very plainly. The area of the openings in the air comb is 7/10 of the area of the openings in the gas comb. The two burners supplying one boiler are inter-connected by necks terminating into the flanges (18). These necks provide a passage from the air and gas chambers of one burner to the air and gas chambers respectively of the other burner.

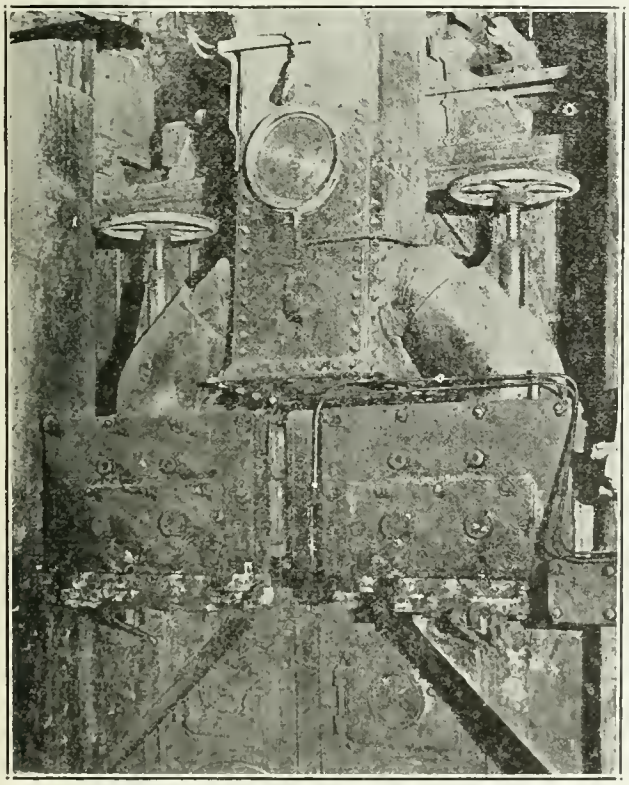


Fig. 7.

making practically one burner of the two separate units. Referring to Fig. 1 again:

The regulator (4) consists of a base plate (42) on which is mounted a column (49) which carries the fulcrum of a scale beam (50). From this scale beam is suspended at one end the gas bell (51) and at the other end the air bell (52). These bells dip into the circular tanks (43 and 44 respectively). The tanks are filled with water to form a seal. Pipe (47) connects the gas chamber with the gas bell and pipe (48) the air chamber with the air bell. If the gas valves are opened, pressure is set up in the gas chamber. This pressure communicates through pipe (47) to the gas bell and moves it up, so that the other end of the scale beam moves down. The scale beam is connected by a rod (77), see Fig. 5, to a pilot valve (75) which is moved from its center position so that it admits service water under about 30 pounds pressure to the operating cylinder (55), causing the butterfly (27) to open. The butterfly is located in the branch pipe from the air header to the burners and air from the fan enters into the air chamber of the burner. As soon as the pressure in the air chamber becomes equal to the pressure in the gas chamber, the springs (53), see Fig. 4, bring the scale beam back to the level position; the pilot valve is thereby brought to its center position again and the butterfly does not open any further. If the gas pressure in the gas chamber fluctuates due to an irregular supply of gas, then the regulator takes care that the pressure in the air chamber also is changed to conform with the change in the gas chamber.

Fig. 6 shows a section through the pilot valve.

Fig. 7 gives a view of one of the boiler burners. On the front of the downleg at the right is a glass jar, partially filled with water. Four glass tubes are dipping into the water. They are connected respectively to the air and gas chambers of the burners of the adjoining boilers and the pressure in these chambers forces the water level in the tubes down. This gauge gives an indication if the pressures in gas and air

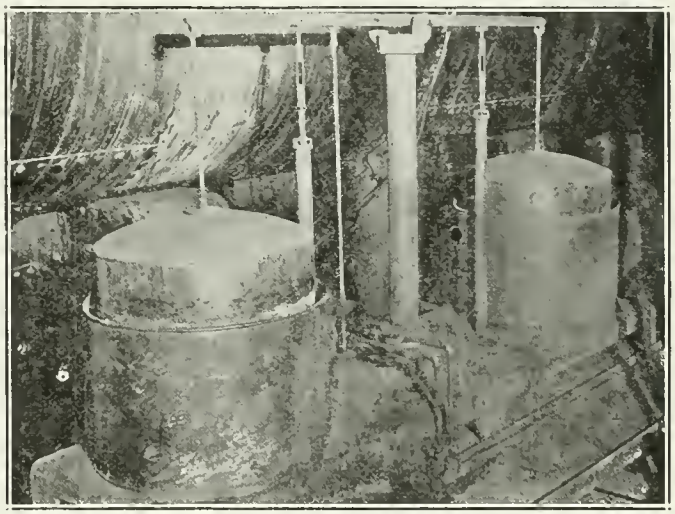


Fig. 9.

chamber are the same and also how much pressure there is. It shows the operation of the regulator, as the water in the gas tube moves it is followed directly by the water in the air tube and the two always keep on the same level. Then it also shows roughly to the fireman how much gas is passing through the burner and how much steam is developed, giving him a guide how far to open the gas valves. Fig. 8 shows a battery of boiler burners, and Fig. 9, one of the regulators.

An installation of stove burners for one blast furnace with five stoves is illustrated in Fig. 10 to 17.

Referring to Fig. 10, in which the burners and their accessories are shown in heavy lines, the upper part gives a plan and the lower part an elevation. The plan shows the location of the motor driven fan in the small house adjoining the cast house. The air passes from the fan through a rectangular duct into the air header which is also rectangular and is located below the hot blast main. On the drawing it is shown in dotted lines. The elevation shows the gas main above the hot blast main a little lower and still lower the air header. At each stove the gas is brought down

through a downleg which terminates at the bottom into a dust pocket. From the side of the downleg the gas passes through a Wilson valve and through another elbow into the burner. Each one of the burners has a regulator, which is located in a little house placed immediately below the gas main. The regulator houses are accessible by ladders and are protected against frost by small steam radiators.

Fig. 11 shows a section through the burner. (A) is the before-mentioned Wilson Gas valve from which the gas enters through an elbow into the gas chamber (B). This chamber is provided with a baffle, C, which serves the purpose of breaking the speed of the gas and removing mud and entrained moisture from the washed gas. After the gas has impinged against this baffle it passes around the same at both sides with low speed into the tube, D. This tube has an orifice ring, E, which gauges the flow of gas into the stove. The air passes from the airduct through a short tube, F, into the air chamber, G, and from there into a circular casting, H. This casting is contracted at the end to form with the outside of the tube, D, a ring-shaped orifice, I, which gauges the flow of the air into the stove.

The area of the air orifice, I, is seven-tenths of the area of the gas orifice, E. The regulator, K, and operating cylinder, L, are of the same construction as the regulator and cylinder used on the boiler burners and operate through the bellcrank, M, and lever, N, the air butterfly valve, O, in such a manner that the air pressure in chamber G, is always equal to the gas pressure in chamber B. Gas and air flowing through the orifices, E and I respectively, propelled by equal pressures, flow with equal speeds and because the proportion of the orifice areas is one to seven-tenths, seven-tenths cu. ft. of air stream P, operated by the handwheel Q, by means of a toggle arrangement, connects the burner with the stove door when the stove is on gas and telescopes over the casting, H, when the stove is on blast so as to provide room for the cover of the stove door. The sleeve makes a tight fit on the stove door and also on the burner and is very easily moved back and forth.

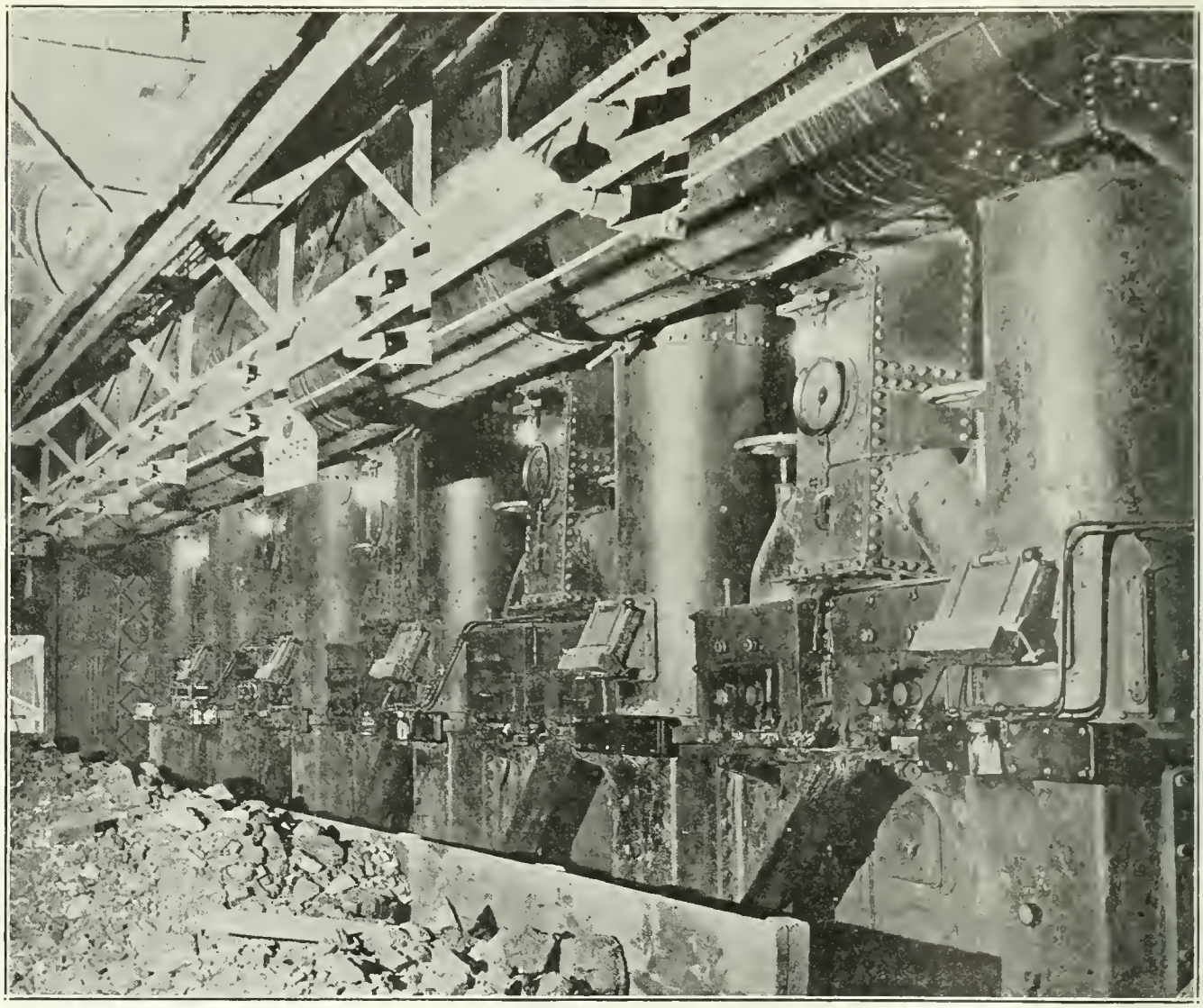


Fig. 8.

Fig. 12 gives a view of the installation. The fan house at the left, the air duct connecting the fan to the air header, the gas main, downlegs, valves and burners. Below, the gas main can be seen two of the regulator houses.

Fig. 13 gives a side view of the burner while the

stove is on gas. The sleeve is moved out against the stove door. From the gas chamber and air chamber, pipes lead to the left and connect to the regulator which is not visible. At the upper left of the picture the rectangular air duct can be seen. A pointer is attached to the lever, N, of the butterfly valve and serves to show the gas consumption on a scale in cubic feet per minute.

Fig. 14 is the same view with the stove on blast. The sleeve is moved back and the air valve in the closed position.

Fig. 15 is a near view of the burner. Above is the gas main, below it on the right and left part of a regulator house, in the center the downleg, gas valve and the burner. Also the two pipes connecting gas and air chambers to the regulators located in the house on the right side.

The results obtained with these burners have been very satisfactory. The burners were first applied to boilers. At Lorain Works all the electric power was generated at that time by steam units which were supplied with steam from the blast furnace boiler house. This house is equipped throughout with the Cahall vertical boilers of 250 hp. Each boiler had a grate surface eight feet wide and six feet deep and were fired with gas and coal combined.

However, through the development of the electric drive in the works, the power demand grew more and more, so that the boilers were not able to make sufficient steam. It was then decided to separate on a number of the boilers the burning of coal and gas, and to use forced draft under the coal fired boilers to

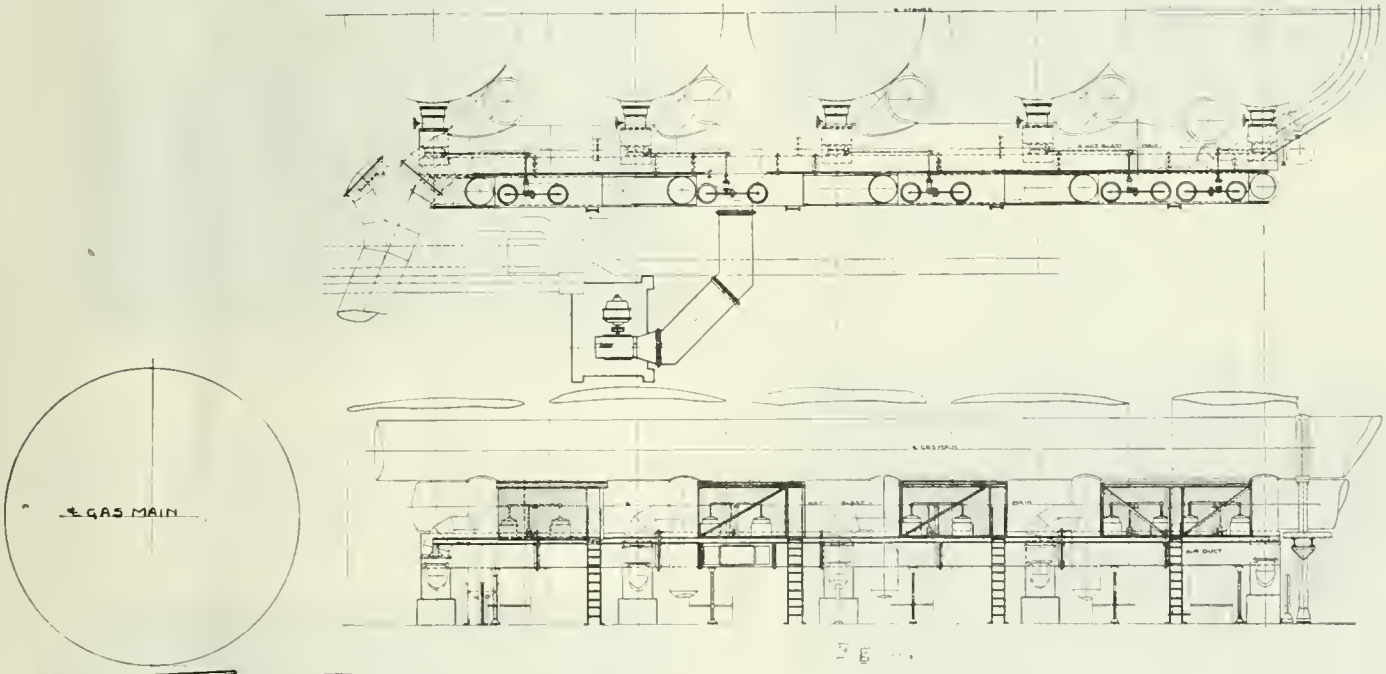


Fig. 11.

get better economy and more steam. However, when the boilers were tried on the gas alone, they would develop only about 180 hp. The part of the boiler opposite the combustion chamber was always black. Forced draft under the coal fired boilers proved satisfactory. Then in order to increase the capacity of the gas fired boilers the new burners were installed and with these there is no difficulty to get the back of the boilers hot. With gas alone, up to 400 hp per boiler can be developed. But when this is done the draft in the combustion chamber changes to pressure as high as 3/10 of an inch. The fire and ash pit doors are bricked up and this keeps the flame from blowing out and burning the doors. The only trouble which has been developing in forcing the boilers to this extent is burning the flange unions on the blow-off pipes and on account of this, these boilers are ordinarily not forced beyond a balanced draft in the combustion chamber. Under this condition, the boilers develop about 330 hp. The stack gases average 22 per cent carbon dioxide, .1 per cent carbon monoxide and 3. per cent oxygen. This oxygen is to a large extent leakage through cleaning doors and other openings in the boiler settings.

It often occurs with other boiler and stove burners that the flame surges back and forth at the entrance to the combustion chamber. If this is the case almost

invariably the stack analyses show unburnt gas. This surging with the natural draft burners affects the air only, because the gas is supplied under pressure and everytime the flame surges out, the air is prevented from entering the combustion chamber. This surging

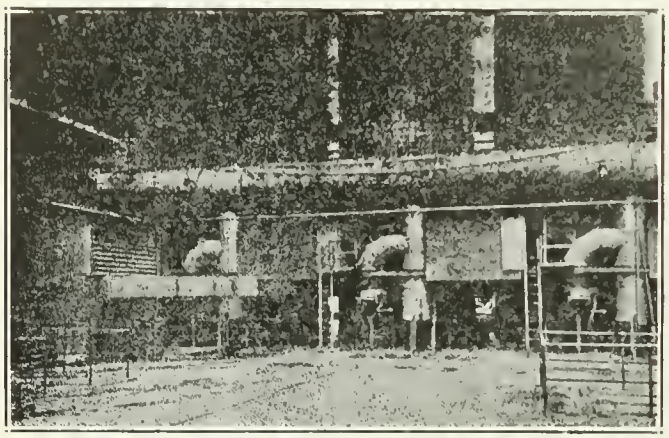


Fig. 12.

sometimes gets so strong that the flame makes it difficult to approach the burners. With the Steinbart burners the annoying surging is entirely eliminated.

When the burners were found to give such satisfactory results at the boilers, a stove burner was de-

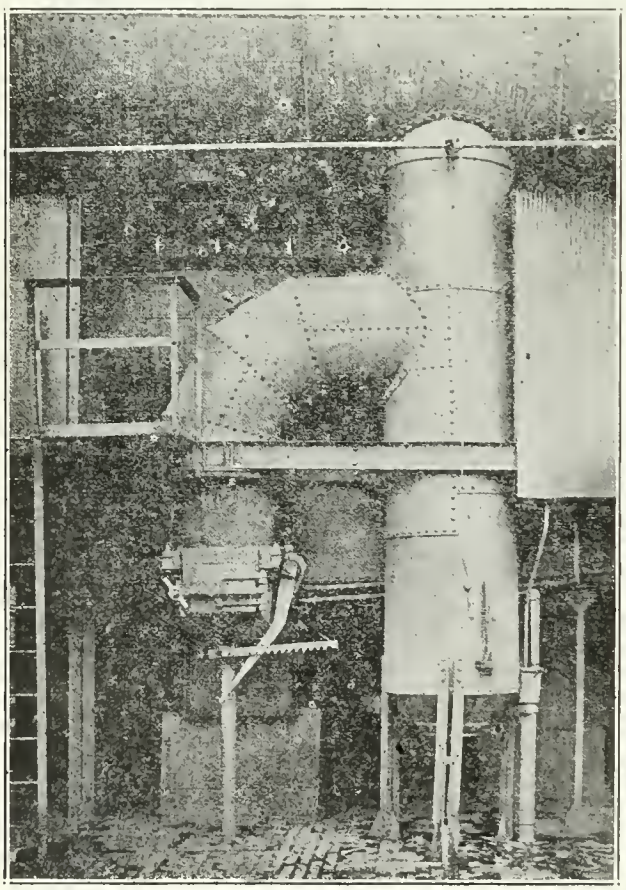


Fig. 15.

signed and tried out. After various changes the stoves of No. 5 furnace were equipped and have been in operation since March of this year. After their installation it was found that when the stoves would be kept on gas only one-half the regular time and then closed up, that as good blast temperatures were obtained as before with the old burners. The gas pressure records before and after the installation of burners showed a rise in pressure over the entire plant which could

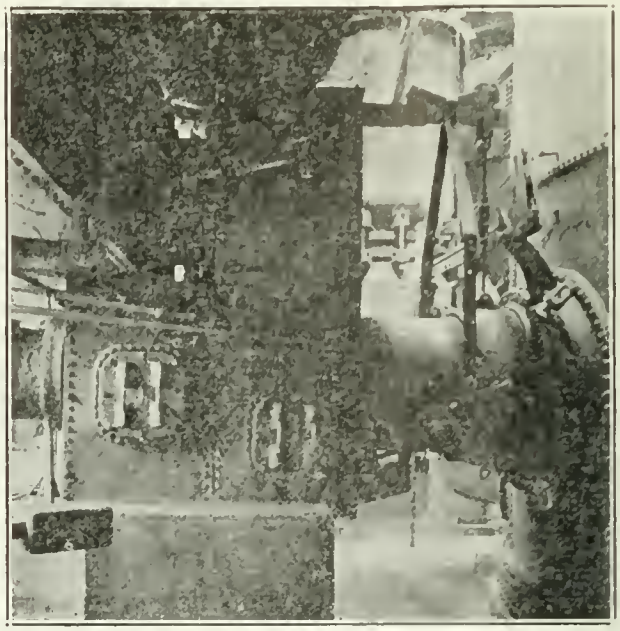


Fig. 13.

not be attributed to anything else than to a saving in gas by the stove burners. Also from an operating point they were successful from the start. The only trouble which has developed was clogging of the water pipes to the pilot valves by a slug or dirty water. A reoc-

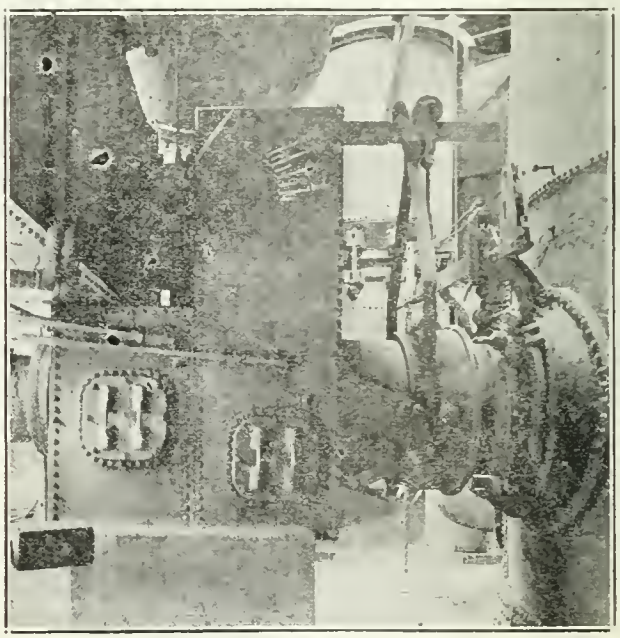


Fig. 14.

currence of this will, however, be prevented by the installation of a strainer. The following stack gas analyses show the performance of the stove burners. The samples were taken regardless of conditions:

Stove Flue Gas Analysis. No. 5 Furnace.

June 1920	No. 1 Stove			No. 2 Stove			No. 3 Stove			No. 4 Stove			No. 5 Stove		
	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO
1 ..	22.8	3.0	.0	23.0	1.8	.0	.....			26.0	.6	.0	.....		
2 ..	25.8	.4	.0	.....			24.2	1.0	.0	25.2	.4	.0	23.2	2.0	.0
3 ..	21.8	2.6	.0	26.8	.0	.0	24.0	1.4	.0	24.2	1.4	.0	22.0	2.8	.0
4 ..	20.4	4.2	.0	24.0	1.2	.0	.....			.....			21.6	3.0	.0
5 ..	21.8	2.8	.0	22.4	2.6	.0	22.6	2.8	.0	22.4	2.6	.0	.....		
7 ..	21.8	3.6	.0	.....			.....			23.4	2.0	.0	23.8	2.0	.0
8 ..	.....			26.4	.0	.0	22.8	2.2	.0	23.4	2.0	.0	.....		
9 ..	22.6	2.8	.0	25.4	.0	.0	.....			23.4	2.2	.0	24.6	1.2	.0
10 ..	.....			.....			23.6	2.0	.0	23.4	2.4	.0	23.2	2.6	.0
11 ..	22.2	2.6	.0	25.6	.0	.0	23.2	1.6	.0	24.8	1.0	.0	23.0	2.0	.0
14 ..	22.4	2.8	.0	23.8	1.2	.0	.....			24.0	1.4	.0	23.0	2.0	.0
15 ..	24.0	1.6	.0	26.6	.0	.0	24.2	1.4	.0	24.4	1.6	.0	.....		
Aver.	22.6	2.6	.0	24.9	.7	.0	23.5	1.8	.0	24.1	1.6	.0	23.0	2.2	.0

Average of 45 analyses CO_2 23.6, O_2 1.8, CO .00.

Stove Flue Gas Analysis. No. 5 Furnace.

June 1920	No. 1 Stove			No. 2 Stove			No. 3 Stove			No. 4 Stove			No. 5 Stove		
	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO
16 ..	23.4	2.0	.0	25.8	.0	.0	.....			23.4	2.0	.0	22.2	2.6	.0
17 ..	22.8	2.2	.0	.....			22.0	3.0	.0	24.0	1.2	.0	21.2	3.6	.0
18 ..	.....			25.2	.0	.0	24.0	1.4	.0	23.8	1.4	.0	23.6	1.6	.0
19 ..	23.4	2.2	.0	25.4	.0	.0	.....			24.6	1.4	.0	24.0	2.2	.0
21 ..	.....			23.6	2.2	.0	23.6	2.4	.0	.....			.....		
22 ..	24.4	1.4	.0	.....			24.4	1.2	.0	25.4	.8	.0	24.8	.8	.0
23 ..	20.2	4.2	.0	21.4	3.8	.0	22.4	2.6	.0	22.4	2.8	.0	.....		
24 ..	21.6	3.6	.0	24.4	1.6	.0	22.8	2.8	.0	.....			20.8	4.2	.0
25 ..	.....			.....			.....			23.2	1.4	.0	22.6	2.4	.0
26 ..	.....			26.2	.0	.0	24.6	1.6	.0	24.0	2.0	.0	.....		
28 ..	.....			24.2	1.0	.0	23.8	1.8	.0	24.0	1.2	.0	22.8	2.6	.0
29 ..	23.2	2.0	.0	25.6	.4	.0	.....			24.2	1.6	.0	22.2	3.2	.0
30 ..	24.6	.4	.0	.....			*20.0	4.4	.0	*19.2	5.0	.0	*18.0	6.0	.0
Aver.	22.9	2.2		24.6	1.0		23.1	2.4		23.5	1.9		22.2	2.9	

Average of all 47 analyses CO_2 23.3, CO none, O_2 2.1.
*Pipes to pilot valves plugged by dirty water.

Stove Flue Gas Analysis. No. 5 Furnace.

July 1920	No. 1 Stove			No. 2 Stove			No. 3 Stove			No. 4 Stove			No. 5 Stove		
	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO	CO_2	O_2	CO
1 ..	22.0	2.8	.0	21.2	4.0	.0	23.4	2.0	.0	.....			21.4	3.8	.0
2 ..	22.2	2.8	.0	25.2	.0	.0	24.2	1.6	.0	23.4	1.8	.0	21.8	3.2	.0
3 ..	.....			24.4	1.0	.0	24.0	1.8	.0	23.2	2.4	.0	21.8	3.4	.0
6 ..	22.0	3.4	.0	22.4	3.2	.0	22.6	2.0	.0	23.2	2.6	.0	.....		
7 ..	23.4	2.2	.0	24.6	1.2	.0	.....			24.4	1.2	.0	26.0	.0	.0
8 ..	.....			23.4	2.4	.0	23.4	2.4	.0	23.2	2.2	.0	23.4	2.4	.0
9 ..	21.8	3.0	.0	23.6	2.0	.0	24.2	1.4	.0	23.2	2.4	.0	.....		
10 ..	22.2	2.4	.0	23.6	1.6	.0	23.2	1.8	.0	23.0	2.2	.0	23.0	2.2	.0
12 ..	22.4	2.4	.0	22.2	1.6	.0	.....			.....			22.8	1.8	.0
13 ..	22.2	2.8	.0	22.4	2.2	.0	26.4	.0	.0	23.6	1.2	.0	24.0	1.4	.0
14 ..	22.2	1.6	.0	23.0	1.2	.0	24.2	.2	.0	.....			23.0	1.4	.0
15 ..	.....			24.0	.0	.0	.....			24.2	.0	.0	23.4	.6	.0
Aver.	22.3	2.6		23.3	1.7		24.0	1.5		23.5	1.8		23.1	2.0	

Average of all the 49 analyses, CO_2 23.2, CO 0.0, O 1.9.

Microscopic Metallography of Steel

Dealing With the Composition, Constitution, Structure and Physical Properties of Steel by the Chemical, Mechanical and Microscopic Methods and the Results of Examination by the Same.

METALLOGRAPHY in its widest sense deals with the composition, constitution, structure, and physical properties of steel.

In the study of steel there are three principal methods of arriving at the solution of most of the problems that arise, but in pursuing the study it must be borne in mind that only in the exceptional cases can the solution to the problem be arrived at by any of these methods. The great majority of cases will require the correlation of the results of at least two of these methods, while in some cases all three will be required. These three methods are as follows:

1. Chemical methods. General analysis and separation of the elements.
2. Mechanical methods. Determination of elasticity, tenacity, ductility, hardness, etc.
3. Microscopic methods. Examination of constitutional and crystalline structure.

Microscopic Metallography—History.

The first records of the use of the microscope as applied to the examination of iron or steel dates back to 1722, but not until 1878 was there much intelligent work done as regards the general laws relating to fractures, crystallization, etc. Between 1878 and 1890 the study was carried on by such men as Osmond, Howe, Charpy and Sauveur, and most of the fundamentals can be traced to the work of these men. However, it was not until after 1900 that the subject was taken up by steel manufacturers and users of steel products as an adjunct to the chemical and physical methods which had been in common use for years. During the past 20 years great advancements have been made in the study of steel by the microscope, and at the present time it is hard to realize that not so many years ago its use was practically unknown.

Results Obtainable.

The chief points ascertainable by the use of the microscope are as follows:

1. The crystalline state of the material and changes in structure due to mechanical and thermal treatments.
2. The constitution of the material, or namely, the differentiation of the various constituents which combine to make up the material.
3. The presence of foreign bodies.
4. Mechanical defects.

Sampling of Material.

When a decision has been made to examine a piece of steel, the correct location for the examination must be marked, as it must be remembered that it is a difficult matter to examine a large section. In most cases there is no need to examine a very large surface, as a section can be chosen which will represent either the average of the whole piece, or in the case of a defect, will enclose the defect. By means of a hacksaw or other mechanical device, a specimen with a surface area up to 1¼-inch square can be removed for examination. If, as in some cases of large sectioned castings, etc., a piece is burned out by means of an oxy-acetylene torch, there should be at least an inch of metal around the part to be examined, and this extra body of metal can afterward be removed by mechanical means. This is done to avoid any change in structure which might have been caused by the high temperature of the torch flame.

When it comes to wire and tin plate, which have very small sectional areas, it is necessary to either fasten several of them together by means of suitable clamps, or else to cast an alloy of low melting temperature about them, before it is possible to prepare them for examination.

Polishing for Examination.

An outline is given below of a successful method of polishing by which a specimen can be prepared for examination and photography in about 30 minutes. When an examination only is desired, and some scratches are not objectionable, this period of time can be shortened.

First: The specimen is held against the flat surface of an emery wheel until all marks of the hacksaw, etc., are obliterated and a flat surface is obtained.

Second: The specimen is then rubbed by hand back and forth on three grades of emery paper, each succeeding one being of finer grit. After each paper, the direction of rubbing is at right angles, so that in turn the scratches of the coarser papers are entirely removed.

Third: The next operation is that of rubbing the specimen by hand on a cloth-covered board upon which a water paste of fine alumina powder is placed. This is continued until the marks of the finest emery paper are removed.

Fourth: The final polishing is done on a cloth-covered board, which is covered with a water paste of very fine rouge. By careful manipulation it is possible to obtain a surface on the steel which is free from scratches, even when the examination is done at rather high magnifications.

Fifth: The rouge is washed off in water, and the specimen is dried by means of alcohol and heat.

Etching, Etc.

The polished surface is now ready for examination under the microscope for the purpose of detecting foreign inclusions or mechanical defects. After this examination has been completed, it is then necessary to bring out the crystalline structure of the steel, in order to determine its other qualities. The most common etching solution for carbon steel is a 10 per cent solution of nitric acid in alcohol. The specimen is immersed in this solution until the structure is sufficiently well defined, when the acid is washed off, the specimen dried, and again placed under the microscope for final examination.

A photograph can be made of the structure of the steel, if so desired, and this photograph is called a

"photomicrograph." As comparisons between structures of various specimens are desirable, a standard magnification should be closely adhered to, and for this work it has been found that 100 diameters makes an excellent standard. This is designated as X-100.

Results of Examination.

First: Crystalline state of the material and changes in structure due to mechanical and thermal treatments.

a. Molten steel consists of a liquid solution of iron and carbon with the impurities, and when cast and slowly cooled, results in a segregate of iron (ferrite) and carbon. From chemical methods it is known that carbon in steel is not in the free state, but is combined with iron to form iron carbide (Fe_3C). At first it was thought that the dark areas seen under the microscope were all iron carbide, but when examined under higher magnifications it was found that these masses were made up of numerous striations which consisted of iron carbide and iron. This combination was given the name "pearlite," owing to its having the appearance of "mother-of-pearl" and it was discovered that this pearlite contained about .85 per cent carbon. Iron carbide was called "cementite," and it contains about 6.67 per cent carbon.

In carbon steel slowly cooled from the cast condition, the grains are fairly large, due to the expulsion of the iron to boudaries of the grain or to the cleavage planes, while the brittleness is due not only to this condition, but also to the fact that the iron itself is by nature brittle.

The higher the carbon in the steel, the larger will be the grain size of the cast steel, due to the correspondingly greater expulsion of the ferrite to the cleavage planes.

b. When ingots are heated for rolling to about 2,200 degrees F., the grains are in practically the same condition as when cast, but when rolling commences these large grains are broken up and so long as sufficiently vigorous work is kept up, any further growth of the grains is prevented. However, when work ceases the growth of the grain re-commences and will continue until the steel has cooled down to its critical range, when all further growth ceases. The critical range of steel is that range of temperature during certain changes in the condition of the ferrite as it passes from the solid solution to the free state.

As large sections, such as 8x8-inch blooms, are usually at a very high heat when rolling is finished, their structure will often resemble those of castings, and on account of this they are apt to be brittle and low in ductility.

c. The structures of billets, bars, plate and skelp, when rolled direct from ingots without any re-heating, are much better than that of a large bloom, because more work has been done on the steel, thus breaking up the casting condition more thoroughly, and as the finishing temperature is lower, the chance for grain growth on cooling has been greatly reduced. Sometimes, however, even these sections show a rather large grain structure, which is proof that they have been above the critical range when rolling has ceased.

d. Angles, structural shapes, plates, etc., which are usually rolled from re-heated billets or blooms, show structures somewhat similar to those of bars rolled direct from the ingots, but owing to the fact that the temperature of this second heating can be more carefully controlled, they are not so apt to show as much variation in grain size.

e. Pipe, which is manufactured by raising skelp to a welding heat, usually shows a structure which is rather large grained, while sometimes, owing to its being left in the furnace too long, the structure is almost identical with that of a casting. This explains the brittleness often found in pipe. In addition to this, the pipe is sometimes burnt in the furnace. Burning is due to the oxygen of the air finding its way into the steel, combining with the carbon, and destroying the cohesion of the grains.

f. Tin plate is usually rolled at low temperatures and the growth of the grains on cooling is very slight. In the case of heavier sheet, however, sometimes the finishing temperature is higher and the grains are larger. It is noticeable that in sheets finished comparatively cold, the grains are very much elongated, and it is because of this condition of the grains that rolled sheets show a very poor ductility when an attempt is made to bend or seam them in a direction parallel to rolling. The object of the black annealing of tin plate is to break up the rolling structure and to allow the grains to so re-adjust themselves as to do away with the weakness in any one direction. The ideal annealing would be to bring the plate to a temperature just above the critical range, hold it for just sufficient time to assure the material being thoroughly heated through, and then cool moderately slowly from the temperature. However, on account of certain difficulties such as oxidation, sticking, deterioration of equipment, etc., it has been found unsatisfactory to anneal at this temperature. Instead the annealing is done at between 1,400 and 1,500 degrees F., and very good results are obtained by this annealing. It is true, however, that the size of the grains after annealing are greatly dependent upon the finishing temperature in rolling, when the annealing is done this lower temperature, and if sheets are finished hot off the mills, they will retain the large grains.

g. Small rounds, such as rods, are rolled from re-heated billets, and on account of the high speed of present-day continuous mills, the heating of these billets is often at very high temperatures, such as 2,100 degrees F. The result is that on the larger sizes the amount of work done is not sufficient to break up the large grains and the rods will exhibit a certain brittleness. In case of high carbon steel, the temperatures must be carefully watched, unless the rods are to be subjected to subsequent heat-treatment, when any overheating can be equalized.

h. The drawing of wire, which is done cold, results in the elongation of the grains, and the more reduction, the greater the elongation of the individual grains. The amount of reduction in drawing which wire will stand depends upon the chemical composition of the steel, as well as its physical condition, and there is a marked difference between different steels. With each draft given the wire, the breaking strength of the wire is decreased, due to compression of the grains, while the ductility is decreased, due to the stretching of the grains. The elastic limit of the wire also approaches the tensile strength as the amount of drafting increases and breakage will occur when they are about equal. If care is taken to stop the drawing before actual rupture of the wire takes

place, it is possible by annealing to bring the condition of the wire back to normal, and then drawing can be re-commenced. By careful manipulation of drawing, and annealing, it is possible to draw steel into remarkably small sectioned wire.

Certain grades of wire are wanted as soft as possible without annealing, and so in such cases it is necessary to give as light a draft as possible in order not to raise the tensile strength nor reduce the ductility.

Second: The constitution of the material, or namely, the differentiation of the various constituents which combine to make up the material.

Ferrite.

This we have previously stated is iron minus any carbon, but with some other impurities. It is the softest constituent of steel, and is always present in the free state in steel containing under about .85 per cent carbon. It has a tensile strength of about 47,000 pounds per square inch and an elongation figure of about 40 per cent in two inches. When etched with the usual acid reagents it remains white and colorless.

Pearlite.

This is the strongest constituent in steel, having a tensile of about 125,000 pounds per square inch and an elongation figure of about 10 per cent in two inches. It is found to exist in all carbon steels when in their normal state and the amount of it present is dependent upon the percentage of carbon in the steel. Steel of .85 to .90 per cent carbon is practically a solid mass of pearlite, while in steels of g eater or less carbon content, the amount of pearlite is proportionately less.

Cementite.

The properties of iron carbide are not as well known as those of ferrite or pearlite, but it is known to be extremely hard and brittle. From this it is assumed that its tenacity was not very great, and results have placed its tensile strength at about 5,000 pounds per square inch. Cementite is only present in the free state in steel containing more than .85 to .90 per cent carbon, so that these steels are composed of pearlite and cementite as against the pearlite and ferrite of the lower carbon steels. When etched with acid the cementite remains very bright, being unattacked and standing in relief.

Martensite, Troostite and Sorbite.

These are the three conditions found in steel commercially hardened. When steel is quenched in water from above critical range, the resultant condition is a martensitic one. This consists of a solid solution of carbon in iron. If the quenching is done in oil, which is not as rapid as water in its cooling effect, both martensite and troostite are present, the latter being a transition period between martensite and sorbite. When the cooling of steel is so regulated that the formation of lamellar pearlite is prevented, but is not so rapid as to form martensite or troostite, an indistinct structure results, this being called sorbite. It is stronger, harder and less ductile than lamellar pearlite, but softer and more ductile than troostite or martensite.

Third: The presence of foreign inclusions in steel.

Phospohrous.

As a general rule this element is held in solid solution in the iron as Fe_3P, but sometimes this phosphorous occurs in badly segregated bands, the phosphorous in these bands standing out somewhat like cementite after etching. When this condition occurs, the steel is made very brittle and when subjected to a high heat such as in the welding of pipe, burning first seems to take place along these lines.

Sulphur.

When it is taken into consideration that the presence of twice as much manganese as there is sulphur present is sufficient to convert all the sulphur which will combine to form iron sulphide (FeS) is practically nil in the more common grades of steel. It is this FeS which causes red-shortness in steel, due to its forming weak membranes around the grains of steel, which result in their tearing apart. MuS occurs in small individual particles, which become elongated in rolling, and unless badly segregated, has little if any, harmful effect on the steel. In steel rolled into thin sections, such as sheets or tin plate, if much of it is present, it does have a harmful effect on account of its breaking up the continuity of the steep and causing small ruptures when seaming is done.

Slag.

In steel improperly refined, particles of slag are often retained in the steel, iron silicate being its most common form. It is purely a mechanical and not a chemical mixture, and the chief trouble with steel having these impurities present is on account of the destruction of the continuity and the embrittling effect that it exerts on the iron in the steel. Iron oxide also is found in improperly refined steel, and its presence is also harmful to the ductility of the steel.

Fourth: Mechanical defects.

Piping.

This defect is the result of the contraction of the steel from the molten to the solid state, caused primarily by the expulsion of the gases from the steel. In all ingots there is some piping, the amount being dependent upon the temperature of casting, grade of steel, method of casting, etc., and the only way in which it is possible to entirely rid the steel of this defect is by cutting sufficient off the bloom rolled from the ingots. This is called "cropping" or "discard." A piped condition of steel can readily be discerned and no description of its appearance is necessary.

Seams.

Seams are of two kinds, principally those at the surface, arising from breaks in the ingot, occurring in the blooming mill; and internal seams rolled out from bubbles of gases left in the ingots in solidifying. Etching will always show them up if present, and usually they are readily seen without the microscope.

Laps.

These are purely a rolling defect and are caused by some particular set of rolls not giving the proper size or shape of section to the steel. This results in an over-fill when the steel goes through the next set of rolls, and the steel folds over on itself, the succeeding passes not removing the defect but often tending to hide it and making it more difficult to find out inspection.

Heating Furnaces and Annealing Furnaces

The Strength of Side Walls, of Partition Walls and of Bridge Walls—The Strength of Door Arches and of Door Jambs.

By W. TRINKS.

PART XXI.

IN THE general run of heating furnaces and of annealing furnaces, the sidewalls cause very little trouble. In some furnaces, however, conditions arise which lead to cracking, sagging, burning out or collapsing. It will pay to study the most frequently occurring troubles.

In very large walls (i. e.: very tall walls or very long walls), the difference in temperature between the inside and outside of wall causes a considerable amount of difference of linear expansion, which has two effects. If the expansion of the inner layers can stretch the tie-rods, the outler layers crack. No harm is done thereby except that the owner of the furnace may raise the question whether or not these cracks are the beginning of the collapse of the furnace. If, on the other hand, the buckstays and tie-rods are

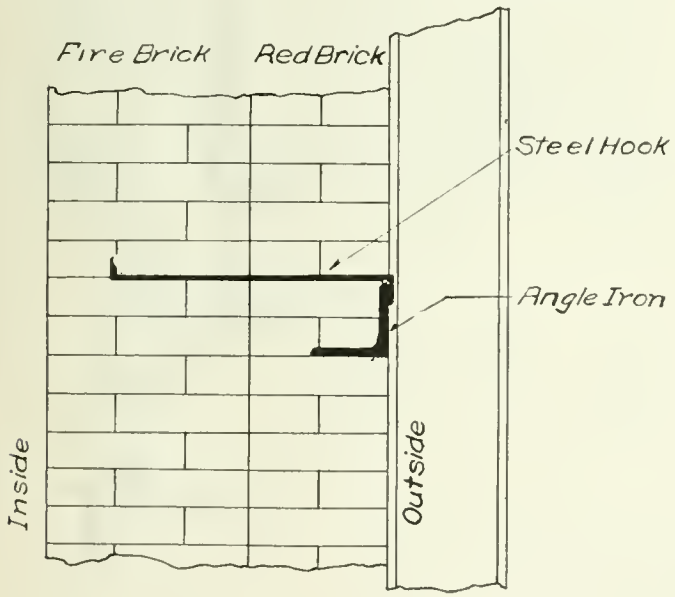


Fig. 149.

strong enough to offer considerable resistance to the expansion, the tendency of the wall is to buckle into the interior of the furnace. Whether or not the inner layers will lift off and fall in depends upon the construction of the wall. If the wall is well bonded to the center or the outside, no trouble will arise. If, on the other hand, the inner layer is not properly bonded, it will peel off and fall in. Now, side wall construction varies a great deal. We find for instance, walls of 9 inches of firebrick, others of 13½ inches of firebrick, others of 9 inches firebrick and 9 inches of red brick, still others of 9 inches of firebrick, 2½ inches of sil-o-cel and 9 inches of red brick. Still others have steel plates or cast iron plates on the outside. Since the buckling effect of walls of long extent is restricted by bonding, it stands to reason that the thickness of the bonded wall should grow with the extent of the unsupported wall. Right here it should be remarked that firebrick and red brick do not bond together very well because of the difference in the brick size; the size of firebrick and of silica brick is 9

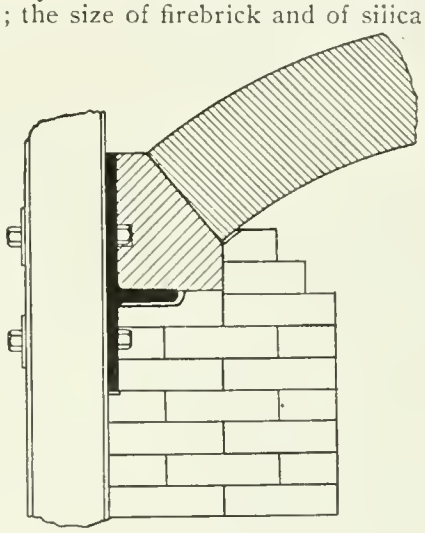


Fig. 150.

x4½x2½ inches, while that of common red brick is 8¼x4x2½ inches. The size of pressed brick is again different, namely 8⅜x4x2⅜ inches. Since in my unsupported rectangle, the shorter side determines the strength, the shortest side whether it be height or length, should be used for determining the thickness of the unbonded firebrick wall. Tentatively we may, in high temperature furnaces, use 4½ inches of firebrick up to 4 feet in length, 9 inches of firebrick up to 8 feet of length and 13½ inches of firebrick up to 12 feet of length. In 1,600 to 1,800 degrees F. furnaces these lengths may be exceeded 40 to 50 per cent. Greater unsupported lengths occur very seldom, and if they do occur, it means either 18 inches of firebrick

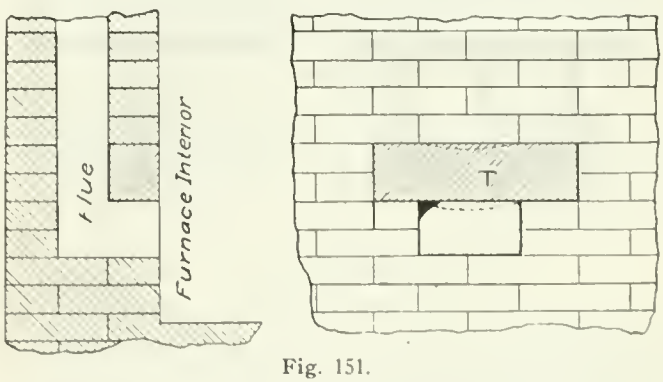


Fig. 151.

or else an auxiliary support for the wall, for instance, by steel hooks, as indicated in Fig. 149.

If sil-o-cel brick is used for insulation, it must be protected on the outside by metal plates or else by red brick, because the sil-o-cel brick is very soft and brittle; besides, the sil-o-cel is, as a rule, used in thin

layers (2½ or 4½ inches) which are not wide enough to stand without additional support.

The peeling off of the inner layer has, up to the present time, prevented the use of the only theoretically correct design of the side walls and arches for batch annaling furnaces. In that type of furnace the latter

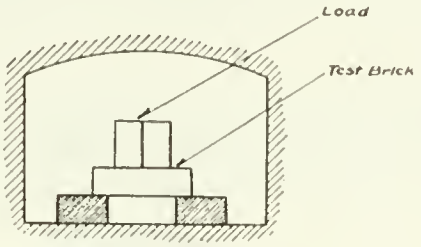


Fig. 152.

is heated and cooled with the charge and frequently absorbs considerably more heat than the charge does, which fact, of course, practically doubles the fuel consumption per pound of annealed material over what it would be without this loss. The latter might be avoided if we could build the furnace of a material which is a perfect heat insulator. Sil-o-cel, while being far from that ideal, is the best insulator known, but cannot be exposed to flame temperatures. Besides it is mechanically weak. Calcined sil-o-cel brick is somewhat stronger, and should be tried out for this purpose, if we can find a design in which the calcined sil-o-cel is protected by a veneer of firebrick against impinging flames. But, as before stated, the problem of holding a 1¼ inch layer of firebrick safely onto a vertical wall has not been solved.

As a rule, sidewalls are held at the top against falling inward, because the thrust of the arch presses the top of the wall outward against the buckstays. But in arches of wide span it is frequently considered safer not to rest them on the side walls (particularly if the latter are cut up by flues and ports), but to rest them on skewbacks which are held by the buckstays, see Fig. 150. This construction is safer for the arch, because the latter is not affected by heat expansion or sagging of the sidewalls, but it is worse for the side walls because their tops are no longer protected

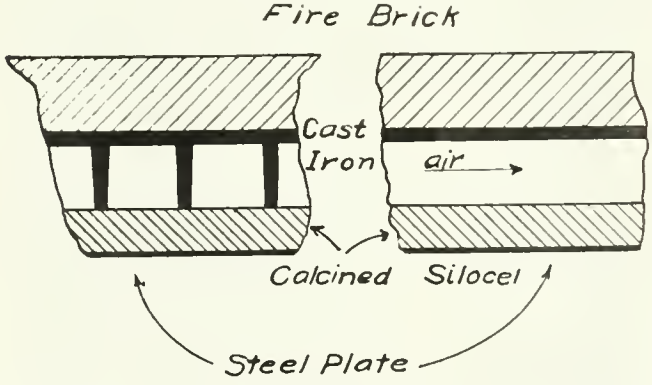


Fig. 153.

against falling inward. The top bricks have a tendency to crawl inward and to loosen the bond. The trouble is avoided by corbling the top of the wall back, as shown in the illustration.

In forge furnaces and in reheating furnaces with temperatures of 2,100 to 2,300 degrees F., holes in the side walls are apt to be troublesome, particularly if these holes are flue openings. Fig. 151 illustrates this case. If the furnace is driven hard, the temperature of the gases entering the flue is very high. The tile T, which spans the flue, then receives convection heat from all sides in addition to radiant heat from the furnace interior. The same is true of the bricks above the tile T. As a rule, hard firing results in softening of the tile, particularly if it lies at the bottom of a tall wall, and in gradual closing of the flue. This undesirable outcome can be avoided, if the tile is made of a sufficiently refractory material. There are such materials in the market, among which "Suprafrax" is perhaps the best known. If this material cannot be obtained, or if its price is considered too high, any other brick made of exceptionally pure fireclay will answer. The suitability of brick for exposed places can readily be tested by duplicating the conditions in a small furnace, as indicated in Fig. 152. Silica brick has been repeatedly suggested for such work, has been tried and has been discarded. Its expansion is so different from that of fireclay that the two will not bond together, but crack right off sharply. Furthermore, silica brick undergoes a recrystallization near 1,200 degrees F. and must be heated or cooled with extreme slowness through its critical range. This requirement is a burdensome restrain to which furnace operators will not submit. The rate of heating and of cooling commonly used in heating furnaces results in the spalling and breaking of the silica brick.

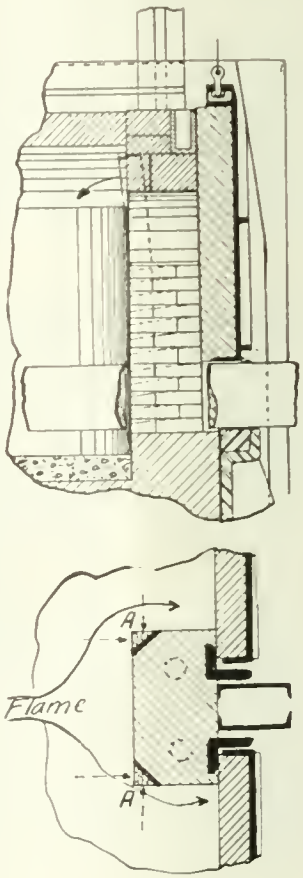


Fig. 154.

There is one type of furnace in which the side walls (and the arches and the hearths, too) wear out rapidly, and that is the high temperature drop forge furnace. It is well known that steel can be heated much more quickly to a given average temperature, if the furnace temperature is considerably in excess of the final steel temperature. Rapid heating results in a great temperature difference between the inside and the outside of the steel which is being heated, but drop forgers apparently care nothing about such differences. Frequently bars are heated at the rate of 4 to 7 minutes per inch of diameter, and that means a furnace temperature of 3,000 to 2,600 degrees F.

And furnace temperatures near 3,000 F. mean "sweating" or fusing of the refractories. As a matter of fact, it is the practice in works carrying these high furnace temperatures, to repair the furnaces every Sunday. A possible solution lies in making the walls so thin that the outer, colder layers by their own mechanical strength, hold up the inner, soft layers. This expedient, however, involves tremendous heat losses, unless most of the heat is returned to the furnace. In an attempt to accomplish the latter feat, I have de-

signed a furnace with thin side walls, thin hearth and thin roof. Air circulates all around and is preheated on its way to the burner. An element of the long, winding air path of the side wall construction is shown in Fig. 153*.

On the inside of the furnace, heat passes into the 4½ inch wall, from which it enters into a cast iron, ribbed shell. The ribs serve three purposes; first, they guide the air on its predetermined path; second, they transmit heat to the air; third, they hold the outer layer of calcined sil-o-cel brick in place. On account of the length of the air path, there is a pressure drop of several inches of water through the length of this path, and the airmust be kept from leaking out. Therefore, the sil-o-cel is surrounded with an air-tight steel shell.

The design in question is heavy and expensive, compared to present practice. It appears that at the present time there is no inexpensive way of building high temperature drop forge furnaces that will last, unless a recently published German method will do the trick. According to that method, painting the inside of the furnaces with a mixture of 75 per cent carborundum sand and 25 per cent of silicate of soda

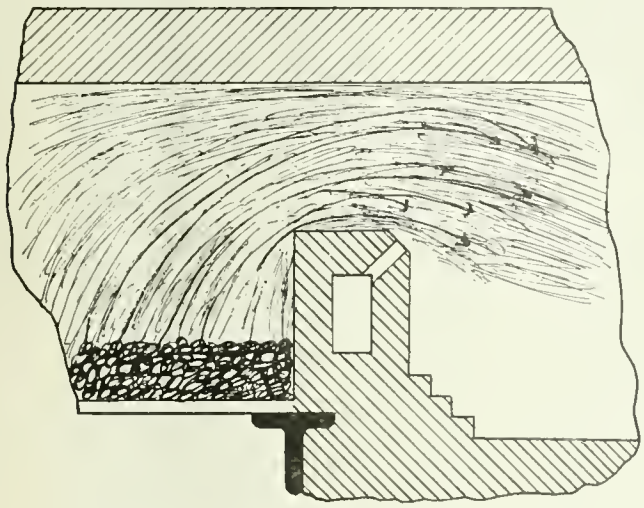


Fig. 155.

considerably increases the durability of furnaces.

Arches over doors, and more particularly over double doors give trouble altogether too often by falling into the furnace. Quite frequently the collapse is due to abuse of the furnace, that is the door jambs are struck by ingots, blooms or billets which are being charged, or else that the door is pulled away from the furnace and then is allowed to drop back. But aside from such abuse door arches fall in, not through any fault of the arches but on account of the giving away of their support. The action is illustrated by Fig. 154. It occurs more particularly in forge furnaces in which a part of the forging projects through the door or doors for a cold tong hold, because with these furnaces the heater tries to force the flame toward the door for the purpose of producing a uniform heat over the whole length of the steel being heated. Flames wash all around the pier imparting heat to it from three sides and causing its temperature to rise considerably above that of the straight side-walls, see arrows in plan view. The corners A, section lined in the plan view, soften and yield as indicated in the elevation. The resulting inclination tips the door arch and allows it to fall into the furnace. The solution of the problem lies in making the pier of especially refractory firebrick, no matter what the cost of such brick may be. In very large furnaces pipes can be arranged for the circulation of cooling water as indicated in the dotted circles in the plan view of 154.

Somewhat similar conditions exist in partition walls and bridge walls. Partition walls occur in double chambered furnaces and are very common in pit furnaces (soaking pits). All of these vertical walls receive heat on both sides and have no protection from outer, cooler layers such as is afforded in outside walls. Yet partition walls will last for years if they are not subjected to a hot, luminous flame. This condition is examplified in soaking pits in which walls, built of a good quality of firebrick will last for over a year, although the temperature of the steel in the pits often exceeds 2,300 degrees F. But the amount of fuel burnt per square foot of wall surface is small.

Conditions are much worse in connection with bridge walls, particularly in coal fired furnaces. Bridge walls are necessary to give length of path to the flame, before it strikes the material which is being heated. They are also necessary for mixing the combustible gases with the uncombined oxygen. In heating furnaces both for rolling mill work and for forge work, bridge walls are subjected to hot, luminous flames, and to the fluxing action of ash particles which are carried along. This statement is true both for coal on the grate and for powdered coal. Bridge walls are indeed hard to maintain in high temperature furnaces. One of the best expedients consists in introducing secondary air through the wall as indicated in Fig. 155. Not only is the secondary air preheated, but the bricks are cooled and are able to resist the cutting action of a flame much better. While cooling by secondary air is quite customary with coal on the grate, it is, as far as I know, never used with powdered coal. With this latter fuel, bridge walls are used but the current of white hot particles must not strike them, as explained in part XVII. In that case the principal function of the bridge wall is to screen the heating chamber from the intense heat of the combustion chamber. If the stream of powdered coal is directed against the bridge wall, before combustion is complete, burning off is certain, and no skill of design will overcome the trouble. Unfortunately, even the builders of equipment for burning powdered coal are not at all certain about the distance within which combustion is complete, and bridge walls erected in accordance with their instructions have been burnt away in a hurry.

As far as the mechanical strength of bridge walls is concerned, they should be made thicker than side walls. If the vertical dimension between supports exceeds the horizontal one, the thickness may be 1/6 of the span for 1,600 degrees F. furnaces, and ¼ of the span for 2,200 degrees F. furnaces.

If, on the other hand, the horizontal dimension exceeds the vertical dimension between supports, the wall must be still thicker, because then the base of the wall furnishes the only support in the central section. In that case the thickness of the wall is ½ (or even 60 per cent) of the unsupported height for 2,200 degrees F. furnaces, and 1/3 of that height for 1,600 degrees F. furnaces.

*Patent protection has been secured for this design.

Operation of a Modern Gas Producer

General Description and Rules Pertaining to the Successful Operation of a Wellman Gas Producer-Operation of a Turbo Blower in Connection With a Gas Producer.

By H. N. TRUMBULL,
Wellman-Seaver-Morgan Company.

IT IS the aim of this article to reduce the operation to a rule of thumb method which will be of assistance to the operator or superintendent and may be applied to every day operating conditions met with in producer practice.

Starting the Producer.

A new producer, before being started, should be dried out several days with small fires. This is a precaution which, if properly carried out, will add considerably to the life of the lining. After the producer has been thoroughly dried, all large pieces of wood likely to cause trouble should be removed and the producer filled with ashes to a depth of at least 12 inches over the top of the blower. It is best that a few large clinkers be placed around the openings of the blower to keep them from becoming clogged with fine ashes. These ashes are necessary to protect the metal parts of the producer. They also act as a diffusing medium to distribute the blast over the entire fuel bed, thus insuring even combustion.

To start the producer, it is necessary only to level off the ashes, throw in several armfuls of small, dry wood, saturate with kerosene, and light with a piece of waste. After the wood has burned for a few moments, turn on about 10 pounds of blast and blow until the wood is well ignited. A small amount of coal can then be dumped and the fires be built up gradually. Care should be taken that the coal is not fed too fast. Allow a good bed of coke to be formed before any attempt is made toward crowding the operation of the producer. One should remember that it takes several hours to get a producer fire built up properly to the point where it is making good gas.

No special attempt need be made at this point to get the fire distributed over the entire fuel bed. It will spread itself later and it is usually better to have a good fire at one point than several small ones scattered over a larger area.

In case it is necessary to stop the producer at any time, the blast should be immediately turned off and never exceed 10 pounds during this idle period.

Three Zones.

The various zones of the producer are three in number. These three are the ash, the incandescent or the fire zone, and the green coal zone, this last consisting of coal which has not received a sufficient amount of air to become incandescent. This is also termed the distillation zone. The existence of these three zones is a point often overlooked in the operation of the producer.

Measuring Fires.

The usual method of measuring the fires is for the foreman to take a rod about five feet long which he inserts in one of the poke holes in the producer top until he establishes the height of the fuel bed. This method is totally inadequate because no attention is given to the depth of the fire zone, the most important point of all in the operation of a gas producer. If the ash zone is allowed to exceed a reasonable limit, say 15 inches, the fire zone is considerably reduced and it is impossible to carry the proper depth of fire if the ashes are not kept within a reasonable limit.

This tendency of the ashes to crowd out the fire zone makes it possible for the top of the fuel to be at the proper height and yet the fire may be so thin that the gas will be of exceedingly poor quality.

The only way the fires can be properly measured is to force the rod completely through the fire and allow it to remain long enough to become red hot. After the rod has been withdrawn, it is easy to see the part which has been in contact with the hottest portion of the fire and the part which has been protected by the ashes. Knowing the distance to the blower or the metal parts of the producer, it is a simple matter to tell exactly the depth of the various zones.

A very convenient rod for this work consists of a ¾-inch gas pipe marked into 2-foot sections by ¼-inch rivets running through the pipe. Any other method of marking may be used which will not be destroyed by the action of the fire or interfere with the passage of the pipe through the fuel bed. A mark is also placed at the height equal to the distance between the blower and the producer top. This indicates the distance the rod should be forced into the producer. The rod is forced through the fuel bed until the lower end is on a level with the top of the blower and allowed to remain there for two or three minutes. This is usually all the time necessary for the rod to remain in the fire. On being withdrawn, it will be noted that there are two parts which show up distinctly—one a smoky black extending for several feet, and the other a very hot portion usually from 12 to 24 inches in length. This latter indicates the incandescent zone. Below the lower point of this zone and the end of the rod, there is a portion not affected by the heat and it should never be less than 6 inches and seldom, if ever, exceed 15 inches.

Between the highest point of the hot portion of this rod and the distance determined to the top of the fuel, there will be a space of from 6 to 12 inches. This is the green coal zone. If the coal is of a tarry nature, it is possible that this zone will stand out distinctly by a tarry deposit upon the rod which can be readily distinguished from the sooty deposit above this section. The sooty deposit of the rod represents the part in contact with the gas.

It is not intended that this method of measuring the fires should be employed more than two or three times per day, depending upon the number of times the fires are cleaned, but this is the only way the ash zone and the fire zone can be measured and the

amount of ashes that it will be necessary to remove be determined.

If the fires are measured just before the change of turns twice a day, it eliminates all chance for the men to excuse their own indifference by blaming the other shift for trouble which might be of their own making.

Hot or Cold Gas.

The green coal zone mentioned in previous paragraphs may vary with requirements. If it is intended to generate a hot gas, that is gas leaving the producer at a temperature of about 1,200 degrees F., the coal zone should not be allowed to exceed 6 to 8 inches. The gas showing when the poke hole cover is removed will be a brownish-black and a small pilot flame or color cone of about 3 inches in length will appear in the center of the escaping gas. If, however, it is desired to generate what is termed cold gas, a deeper layer of coal must be carried over the incandescent fuel. This may be anywhere from 8 to 15 inches, depending more especially upon the nature of the fuel. Under these conditions the gas appearing when the poke hole cover is removed will be a bluish-white and the temperature when leaving the producer may be as low as 700 degrees F. This is by far the richest and best gas for most purposes. The hot gas usually carries a Btu value per cubic foot of about 150, while the cold gas may have a value of 170 to 180 Btu per cubic foot.

Some operators insist that cold gas will not operate efficiently in open hearth furnaces or other places where it is desired to carry a melting temperature. This is a matter open to some discussion. There are, however, several open hearth plants in very successful operation using cold gas by preference.

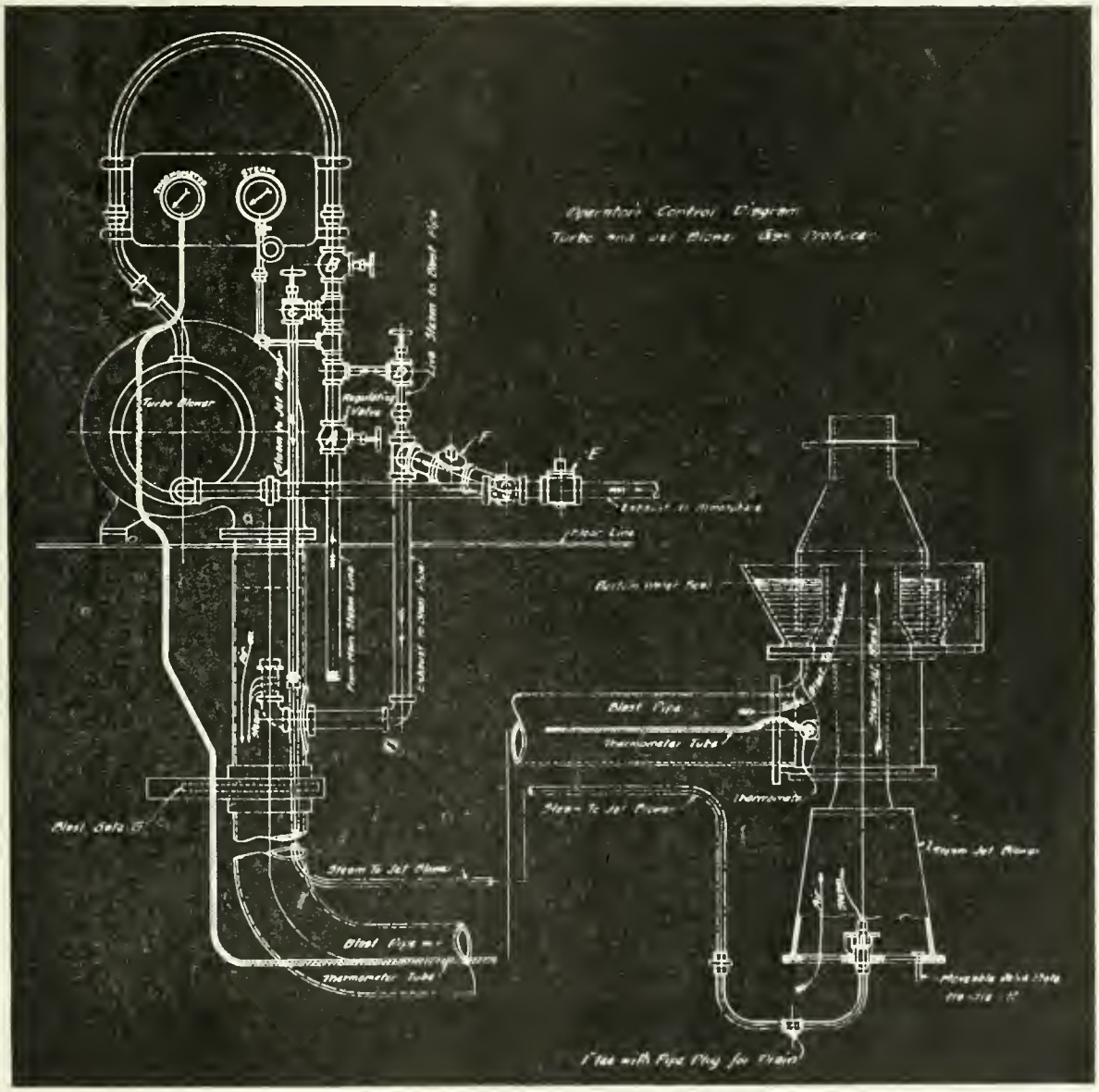


Fig. 1—Turbo-blower with gas producer.

Points of Interest.

Some coals have a tendency to become soft and pasty under the action of the heat in the producer. This restricts the passage of the gas and owing to the fact that the pressure accumulates under the steady blast, the gases will seek channels to break through the resistance of the fuel bed. These points then become excessively hot, melting the ashes and other

foreign particles in the coal which form the basis of clinkers.

If the coal in use is of this nature, care should be taken to see that these channels do not form. This can be done by close attention to the stirring and the regulation of the blast or it may be necessary to change the mixture of the blast increasing the proportion of steam to the amount of air blown. This will lower the temperature of the fire and thus considerably decrease the tendency for the fires to clinker. It should not be carried to the point where the CO_2 content in the gas becomes excessive or the fires are so cooled that the carbon in the coal is not properly gasified. Either of these items determine a certain amount of loss, but the situation should be considered as a whole and decision made as to whether the stoppage due to clinkering and the extra labor attendant to the same are not more than offset for the few percentages of the CO_2 or a slightly increased amount of carbon in the ashes.

Cleaning the Fires.

It is the usual custom to clean the fires about two or three times a day, depending upon the amount of coal burned and the percentage of the ash in the coal.

It is not necessary that the operation of the producer be discontinued during the cleaning period. The fire should never be lowered more than 8 to 10 inches during one cleaning period, and coal should be dumped as during the regular period, although usually in smaller amounts. It is better to lower the pressure on the blowers 10 or 15 pounds during this period. If two or more producers are arranged to operate on the same line the other producers should be blown slightly harder during this interval and if this operation is properly carried out, the entire battery of producers may be cleaned without the slightest effect noticed in the operation of the furnaces. During the cleaning period, careful attention should be given to any clinker formations, that are likely to appear on the side wall. These should be broken loose and the side walls kept clean.

Feeding Coal.

The proper dumping and distribution of the coal charges have a decided bearing upon the conditions obtained in producer operation. The coal should be dumped in as small quantities as can be conveniently arranged and strict attention should be paid to the color and appearance of the gas which shows whether or not the fuel bed is of the proper thickness.

Operation of Steam Jet Blower.

The amount of steam required to blow the producer varies with requirements. If it is necessary to crowd the machine more air is needed to burn the increased amount of coal and as the proporton of steam and air must be maintained, it is only necessary to increase the steam pressure until the proper amount of air is delivered. This in no way affects the quality of the gas if the fires are kept in the proper condition. Gas of just as good quality can be made at 100 pounds pressure as at 15 pounds—only the volume will be greatly increased and it is possible for the fires to get out of order much more quickly. It is hard to set a definite limit upon the amount of steam required but as a general thing it is seldom necessary to use more than 40 pounds of steam to get the desired results.

Operation of Turbo Blower.

The arrangement of turbo and jet blower in combination, calls for a slightly different form of manipulation than for the old simple jet type alone.

To begin with, it is never intended to operate these two systems simultaneously, the only reason for the two systems being for the purpose of reliability, providing means for operating the producer should an accident occur to either of the systems.

The amount of moisture mixed with the blast is always under control, but care should be taken that this is not allowed to become excessive. If the saturation point is allowed to go over 140 to 145 degrees as a usual practice trouble is likely to be encountered by the coal being kept so soft that it will crumble to a fine powder in the producer, and stop the passage of the gas completely. The best results will be obtained with careful operation if the fires are kept as near the clinkering point as possible, except at the cleaning periods when the saturation point can be raised a few degrees, and brought back to normal as soon as the fires have been cleaned.

For the operation of the turbo blower in starting a producer, the valve plate on the steam jet blower marked H in the drawing, Fig. 1, should be completely closed. The blast gate G on the blast pipe from the blower should be wide open.

Valves C, D and F should be tightly closed, and the valve E should be open.

All the regulating for the amount of steam to either the turbo or the jet blowers, should be done by the valve A. This will give the pressure, at which the producer is being blown, on the gauge, and under no conditions should the valves B or C be used to regulate the blowers.

With valves set according to the above instructions the action is as follows:

The steam from the main line is regulated to the turbo by the valve A. The pressure on the producer is registered on the steam gauge. After passing the valve the steam flows through the turbo and out the exhaust pipe through the valve E to the atmosphere.

Under these conditions no steam is being delivered to the producer which is being blown with pure air alone. During ordinary operating conditions, with this arrangement, the fires would become excessively hot and likely to cause clinker trouble, but for starting a new producer if no steam is injected with the air, fires can be brought up to the proper working conditions much more quickly than with the old jet type of blower.

After the fires have attained the proper depth and the producer is making gas, the valve F should be opened and valve E closed and during ordinary operating conditions it should never be necessary for these valves to be again disturbed.

With this arrangement of valves the exhaust steam from the turbo is mixed with the air going to the producer, and the percentage of steam obtained will be registered on the thermometer gauge.

Usually the amount of exhaust steam is not sufficient to provide the necessary moisture which keeps the fires properly softened. To obtain this required amount it is necessary to use live steam. This is obtained by means of the valve D. A slight opening of this valve will allow the live steam from the main

line to pass directly into the exhaust line from the turbo and with this arrangement the blast temperature can be brought to any point desired.

If it is desired to operate the jet blower alone the valve plate H should be opened. Valves B, D and the blast gate G should be closed. Valve C should be opened wide and the regulating of the blower done from valve H. With this arrangement of valves the operation will proceed exactly as for the old jet blower.

Cooling Water.

In starting a new producer the top plate has a tendency to run hot and will usually require about all the water that can be applied through the three connections furnished. After a few days the top plate becomes coated with carbon and the quantity of the water can be considerably reduced. The overflow from the poker is usually sufficient for all purposes and this amounts to approximately 15 to 20 gallons per minute.

If for any cause the water pressure should be lost so that no water will flow through the poker, the producer should be immediately shut down and every effort made to keep the poker cool by means of an emergency line of steam or air. Caution should be exercised in starting the water to flowing through the system because if a large amount of cold water is allowed to strike the poker there is danger of the point breaking, making its replacement necessary.

The life of a poker tip is from six months to a year, depending considerably upon the condition in which the operator has kept his fires. This tip is a separate point screwed into the main barrel of the poker while the latter is heated to a cherry red color. This method of applying new tips should be used to prevent their working loose under the action of the fire. It is good policy to have a spare poker and trunnion changed if it is necessary to make a replacement during the operating period. This operation should not require more than 20 minutes.

Shutting Down.

In most installations there are periods when the furnace is down for repairs. This time should be taken to clean out the producer completely. The side walls should be cleaned, the blower and blast boxes cleaned out and any mechanical part needing attention should be repaired. This procedure, if carried out, will never amount to a great deal of labor and it will be more than repaid by the increased reliability of the machine and the success attained in its use.

Gas Making Conditions in the Producer.

The quality of producer gas depends upon its combustibles. The quantity and character of these are affected by the operating conditions within the producer. During the ordinary operation a battery of Wellman producers in a steel mill, 75 tests were made. Briefly stated, the following conclusions were drawn from these tests:

To make a rich gas, high in British thermal units, the ashes should be maintained at a height of a foot above the blast cover.

The combustion zone should be confined to a thin fire, approximately six to eight inches in thickness.

The green coal zone in which distillation of hydrocarbons (which enrich the gas) occurs should be kept from 12 to 18 inches thick.

Under these conditions the pressure of steam used for the blast should be 23 pounds per square inch.

Such operation produces gas in which a greater part of the calorific energy is due to its combustibles, rather than to its sensible heat. This is desirable as the heat losses during transmission to the point of consumption are less with a cool gas as compared with a highly heated gas.

The rate of gasification was 24.9 pounds of bituminous coal per square foot of producer cross section per hour, or 1,960 pounds per producer per hour, as the consumption of gas did not require a higher rate at the plant under consideration.

The pitch of the curves of the diagram, together with the heat value of the gas, indicate what results will follow a departure from the most favorable operating conditions.

THE MANUFACTURE OF MERCHANT BARS.

(Continued From Page 523.)

independent motor drive, Nos. 7 and 8 stands being driven by a 700 hp motor at 450 rpm and Nos. 9 and 10 stands and Nos. 11 and 12 stands by 500 hp motors at 600 rpm.

The bar is repeated into all passes from the last roughing stand to No. 12 finishing stand. Snap shears are provided in front of each of the finishing passes, and small snap shears for test pieces are located in the runout trough to the cooling bed. The cooling bed, 460 feet long, is of the Edwards double-escapement type. Located at the end of the bed and on each side are the bar shears, back shear rabbles and scales, where the material is sheared to desired lengths and weighed before shipping or stocking. When the mill is rolling rods, or other material that requires coiling, the bar, after leaving the last finishing stand, goes to the rod reels, of which there are four, of the Edwards type with multiple disk drive and brake. The reels are belt driven from the finishing mill. The bundles are dumped from reels directly into a muffled conveyor, which delivers them to a bundle carrier 470 feet long, on which they are carried until cool. Scrap shears and a scrap-bundling machine are located near the mill end and at the side of the cooling bed, while at the south end of the building, near the warehouse, is located a roller straightener for straightening shapes. Electric current for operating the mill is from the same source as 12-inch mill.

A charging conveyor carries the billets from skids in the billet yard to the Morgan continuous heating furnaces, from which they are discharged to the roughing mill by means of a Hawthorne twist push-out. The furnaces use coke-oven gas or oil for fuel, the gas being piped from the Koppers by-product coke plant at East Youngstown. Both the 9-inch and 12-inch mills are served from a common billet yard and use a common warehouse for stocking purposes. The billet yard at the end of the mill is 90 feet wide and 594 feet long. It is served by one 15-ton double-hook crane and two standard-gage tracks for unloading material. The warehouse, at the south end, is 100x396 feet in size with one 15-ton double-hook crane and four depressed tracks for loading material from stock. A millwrights' shop is located within the mill building. All sanitary equipment, lockers and wash room are centralized.

Design of Experimental Rolling Mills

Description of Details of the Design of the Experimental Mill of Bureau of Rolling Mill Research—General Features of the Different Types of Mills When They Are Assembled.

By W. B. SKINKLE,
Director, Bureau of Rolling Mill Research.

PART IV.

HAVING discussed the design of the roll housing at some length we can now consider the details of the various mills into which this housing may be assembled.

Fig. 24 shows an assembly of this housing when used as an 18 inch 3 high bar mill.

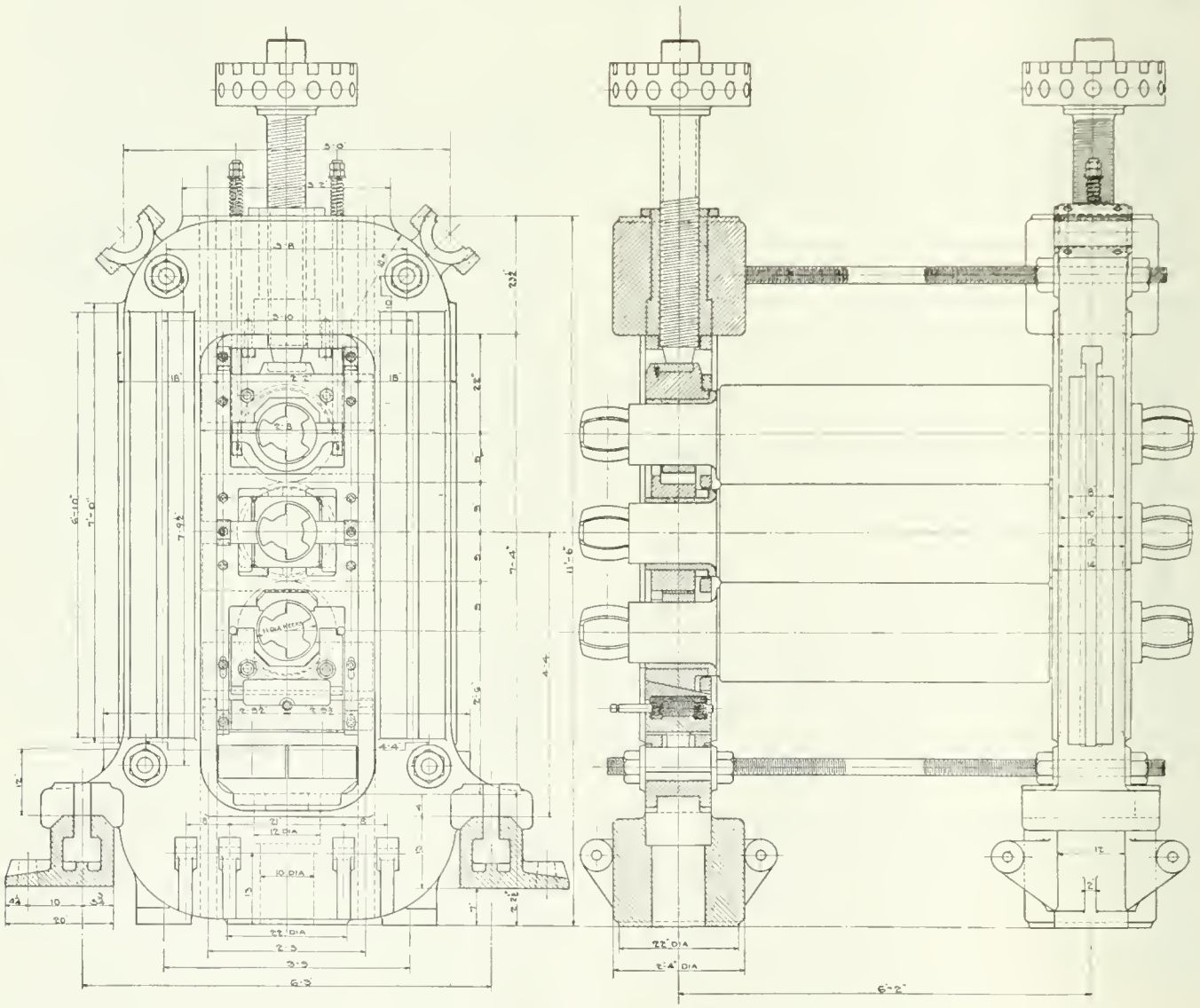


Fig. 24.

The middle roll is carried on a yoke which transfers the load to the bottom of the window. A duplicate casting is inverted and transfers the upward thrust of the middle roll to the top of the window.

The yokes are adjusted in order to take up the wear of the middle roll brasses by means of wedges, one at the middle to hold the yokes apart and one at the ends of each yoke to push them together. Between the wedge and the top of the housing is a filler piece. The function of this piece is simply to "kill space" and avoid sharp corners on the roll housing thereby avoiding the resulting high fiber stress.

The middle roll is held rigidly in place in this manner.

The top roll is carried in the usual manner and needs no explanation. The carrier for the bottom roll rests on a screw by two rollers. The support for the wedge is

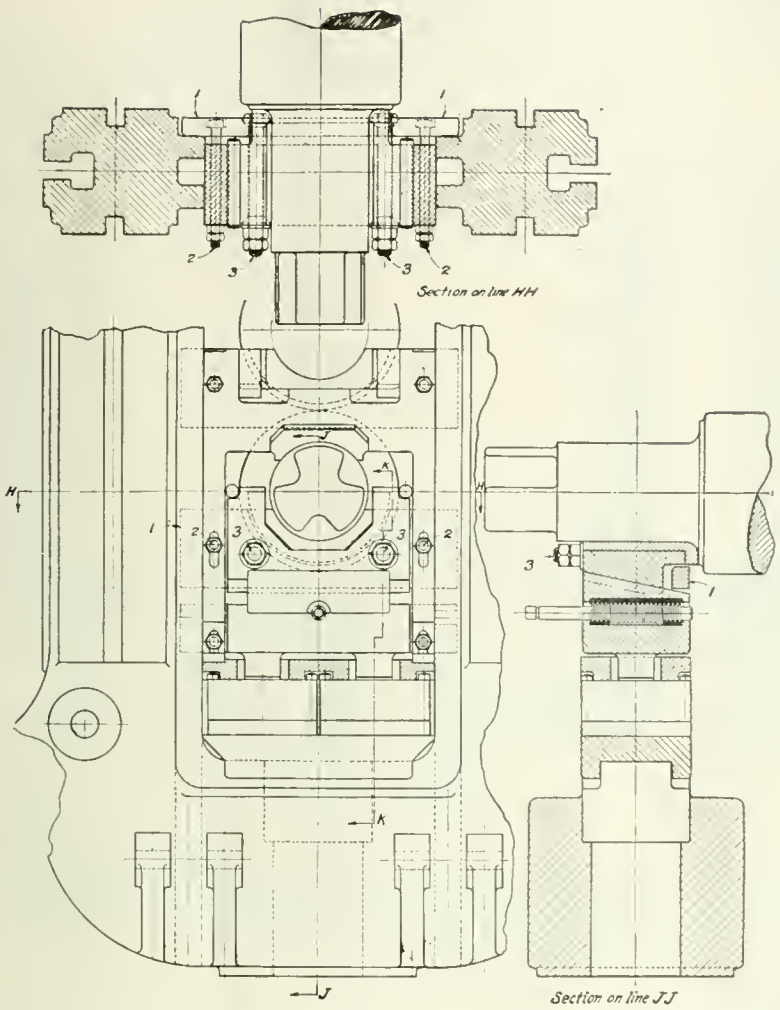


Fig. 25.

carried on two hydraulic support cylinders which will automatically record the load on the roll neck and the friction losses resulting from this load.

Figs 25 and 26 show this construction in greater detail.

Fig. 27 is a diagram of the action of these two hydraulic support cylinders.

Inasmuch as a complete explanation of the action of these cylinders and the development of the equations has already been published in the January, 1920, issue of The Blast Furnace and Steel Plant it will be sufficient to repeat only the equations themselves at this time. In the following equations let

P some fraction of the separating force F which is transferred to one roll neck.

R Radius of the roll.

U The angle whose tangent is the coefficient of friction.

D Distance from centerline of roll neck bearing to centerline of hydraulic cylinder.

d distance from centerline of roll to point of contact between neck and bearing.

N some fraction of P greater than one half

M Some fraction of P less than one half.

W Work lost in friction per revolution of the rolls.

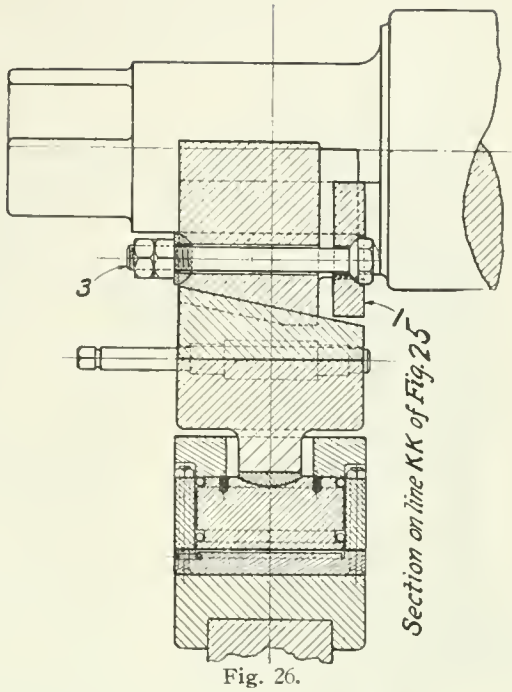


Fig. 26.

Then—

$$N + M = 1 \quad \ldots\ldots 1$$

$$N P + M P = P \quad \ldots\ldots 2$$

$$\text{Sin } u = \frac{(NP - MP)\ D}{(NP + MP)\ R} \quad \ldots\ldots 3$$

$$W = (NP + MP) \sin u\ 2\pi R \quad \ldots\ldots 4$$

$$W = (NP - MP)\ 2\pi D \quad \ldots\ldots 5$$

It is interesting to note that placing equation (4) equal to equation (5), equation (3) will result thus $(NP + MP) \sin u\ 2\pi R = (NP - MP)\ 2\pi D$ from which $\sin \pi = \frac{(NP - MP)\ 2\pi D}{(NP + MP)\ 2\pi R}$ and cancelling the 2 's we have $\sin U = \frac{(NP - MP)\ D}{(NP + MP)\ R}$

These hydraulic support cylinders are to be used in both the mill and pinion housings and will register the losses from friction at these points as well as the loads on the housings. They will not however record the total transmission losses between motor and rolls. The measurement of these losses presents a second important problem.

Figs. 28 and 29 show a method by which these losses may be obtained.

When a bloom is being rolled, the heavy pressure between steel and roll causes the roll to deflect as shown

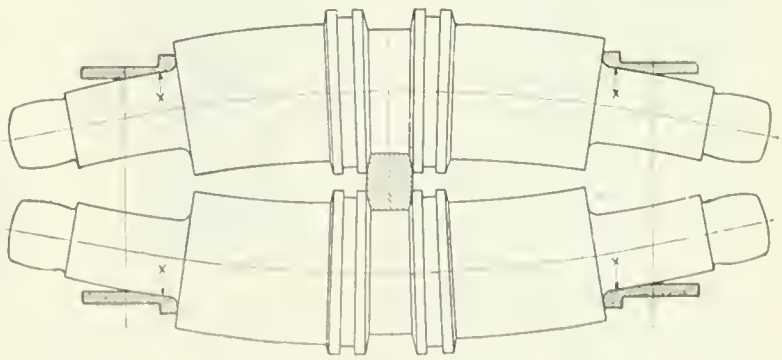


Fig. 28.

in the exaggerated Fig. 28, placing the maximum bearing pressure at or near the inside of the bearing as shown at "X" while the pressure is moved out as shown at "Y" of Fig. 29 when the roll is running light and is not deflected due to the bloom. It would therefore be almost useless to return the load to the roll necks by means of the housing screws or hydraulic cylinders, unless a means is found to deflect the rolls to the same elastic curve which they had when the bloom was being rolled and by this means restore the same conditions of roll neck bearing and lubrication.

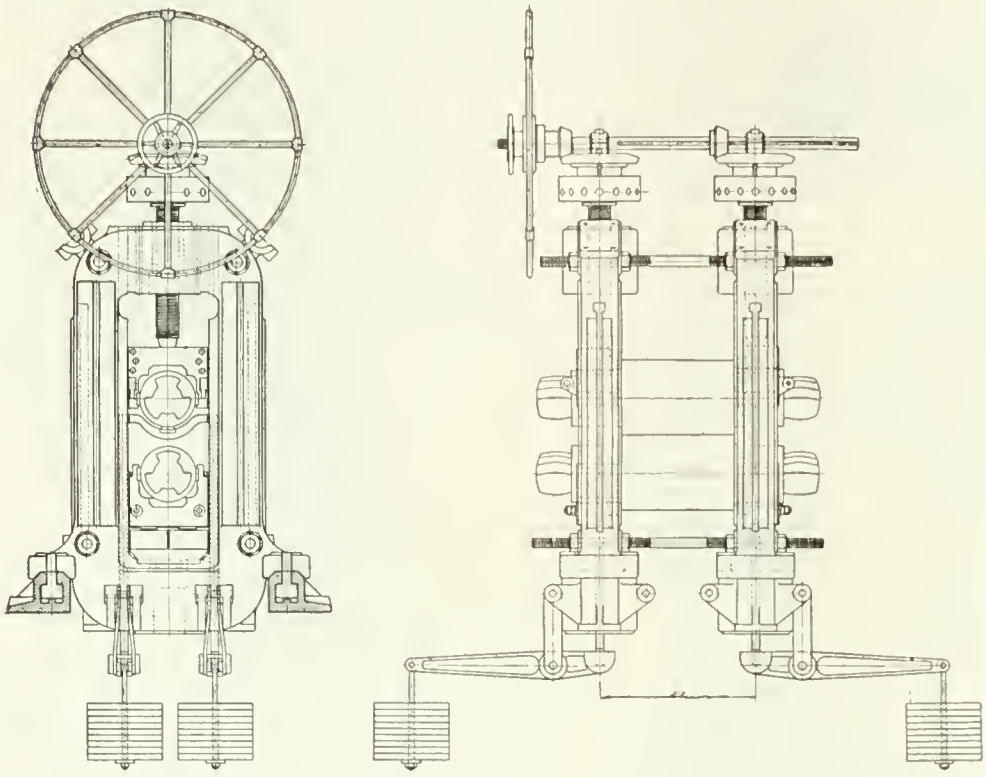


Fig. 30.

This may be done by inserting two hardened steel rings marked "Z" in Fig. 29 in grooves at each side of the pass and then raising the pressure in the hydraulic support cylinders until they record the same pressures that existed during the rolling of the bloom. The hardened steel rings will not elongate or change their shape, therefore no work will be done on them. The coefficient of rolling friction on machined surfaces of this kind is very low, low enough to be well within the allowable percentages of error. The loads on the transmission machinery will therefore have been restored except for the network required to roll the metal. The readings of the watt meter will record the overall losses between switchboard and rolls and the difference between watt meter readings when operating in this manner and when rolling a bloom will be the net work required to roll the steel.

In this manner the losses at various points may be located and analyzed, and comparative results when handling the same section at the rolls but with different bearing metals and lubricants, may be secured, and they should yield valuable data.

Fig. 30 shows an assembly of the large closed top housing when used as a 24 inch balanced sheet mill. The top roll balancing mechanism may be omitted if work as a jump mill is to be done or the same housing and fillings may be used for cold mill work.

Fig. 31 shows this housing when assembled as a 24 inch 3 high plate mill with a 16 inch middle roll. The bearings at the top of the housing carry cross shafts of the synchronizing mechanism for the middle roll while cylinders to raise and lower this roll are bolted to the shoe plates beside the housing feet.

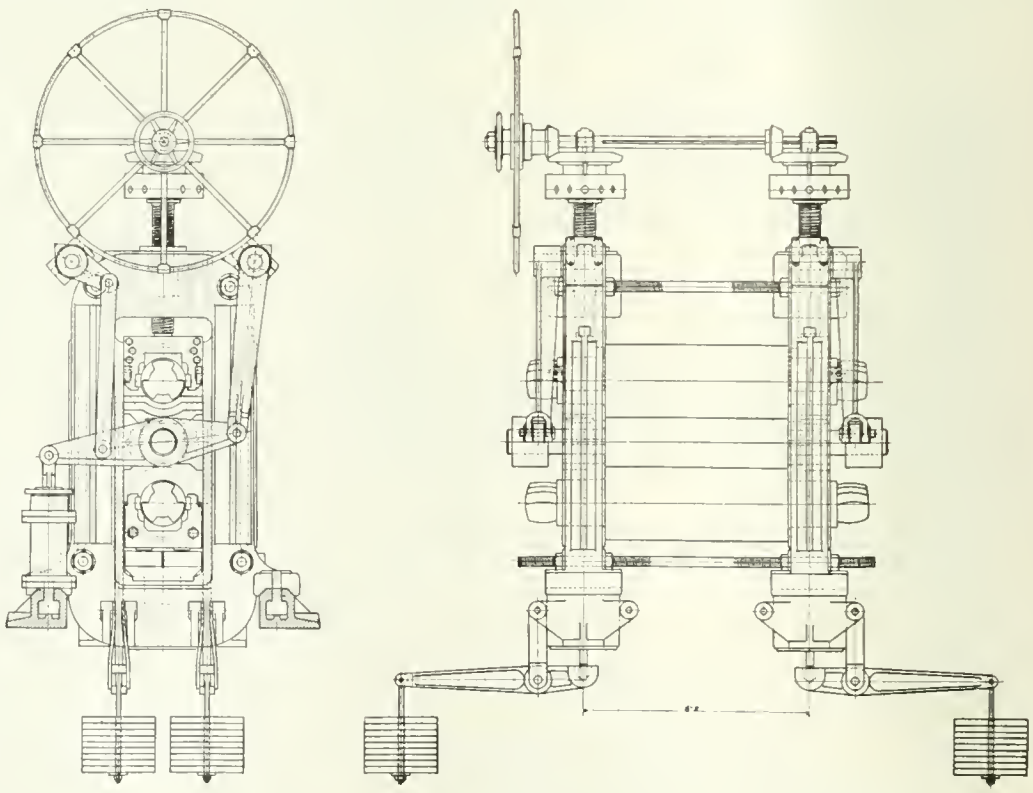


Fig. 31.

Fig. 32 shows a cross section through the laboratory with this mill connected to the drive.

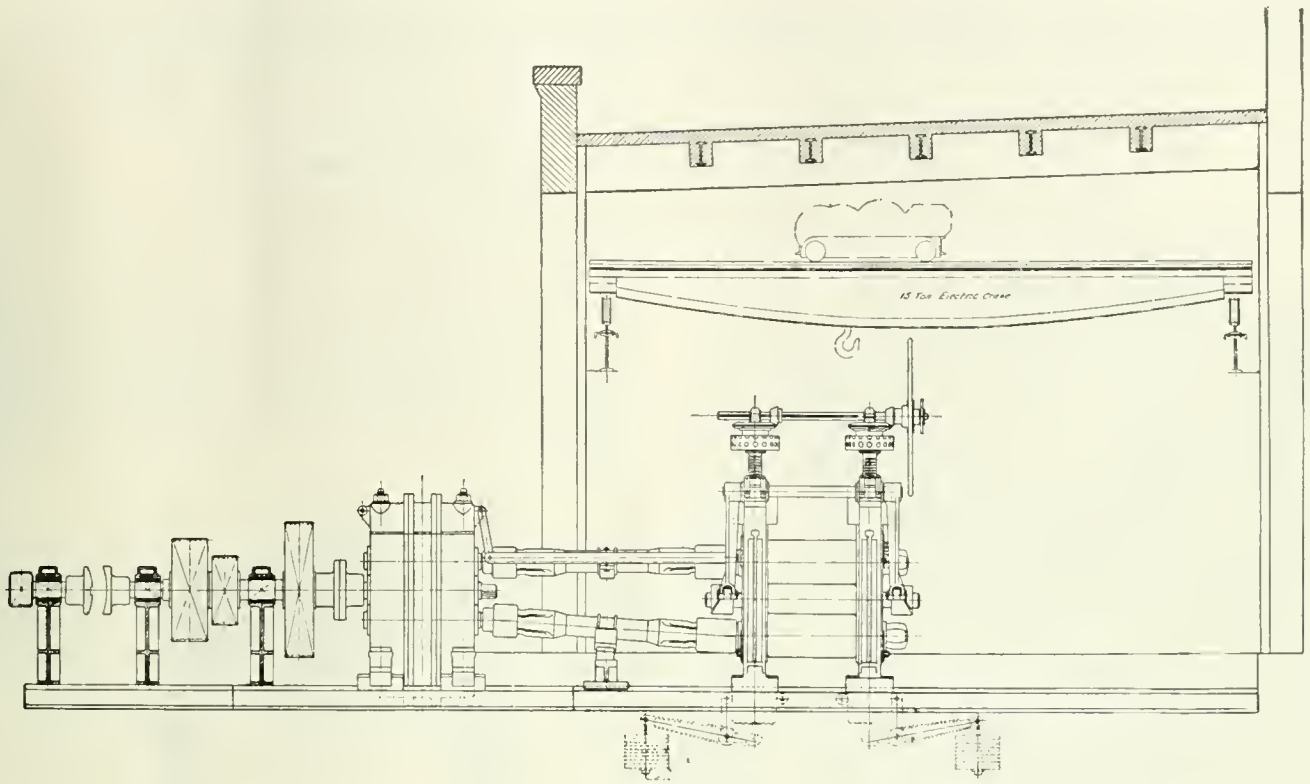


Fig. 32.

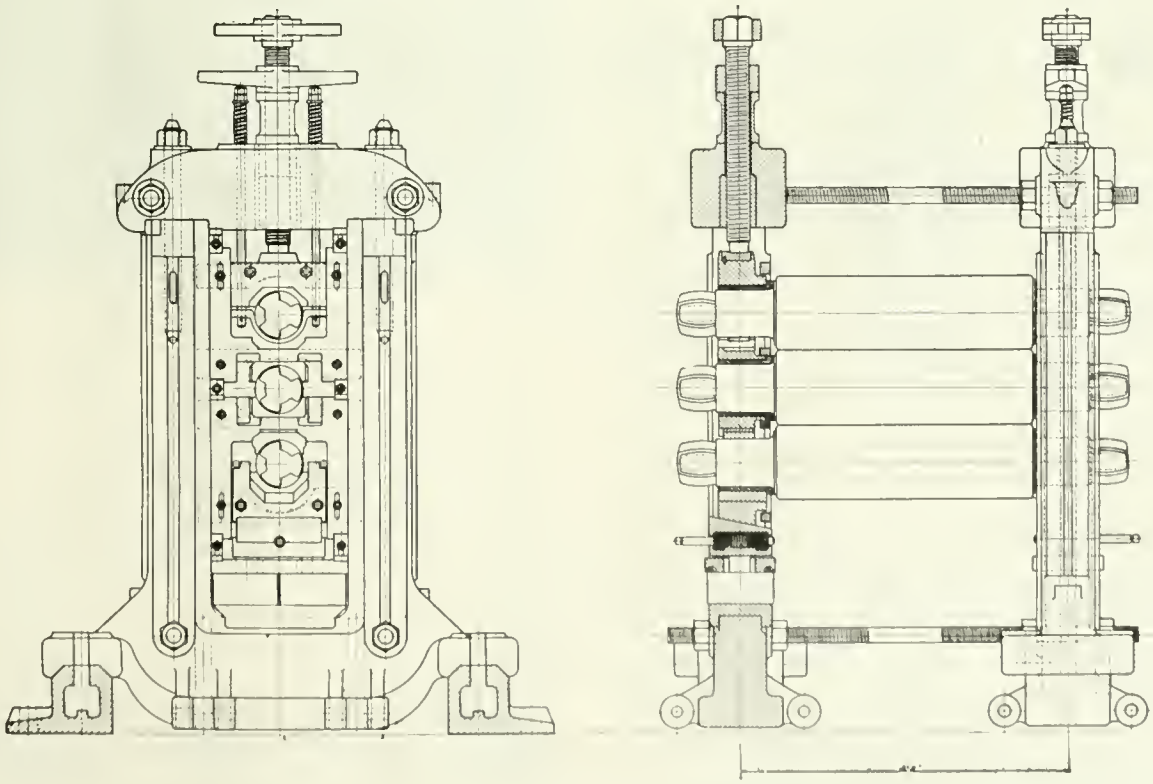


Fig. 33.

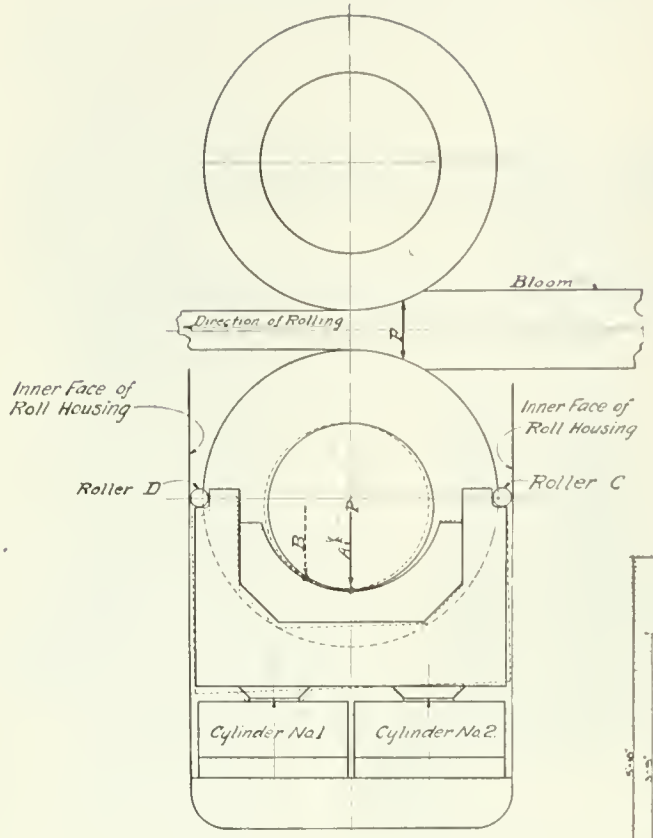


Fig. 27.

The middle roll and its operating mechanism may be omitted and the mill assembled with either 24 inch plate or blooming mill rolls if it is desired

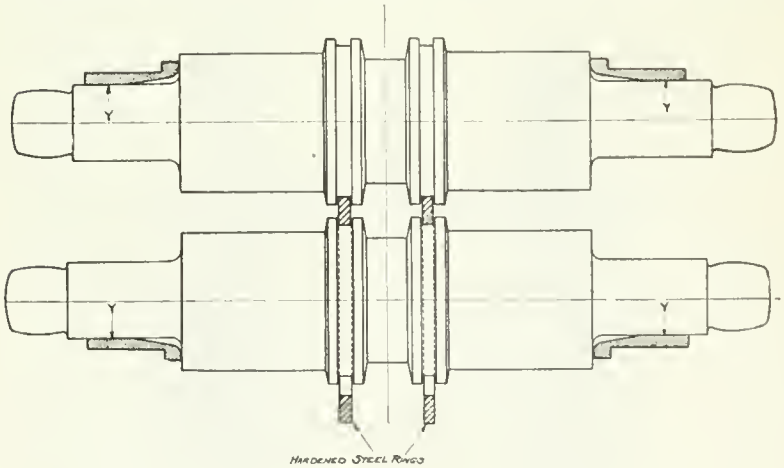


Fig. 29.

to operate either of these types of two high reversing mills.

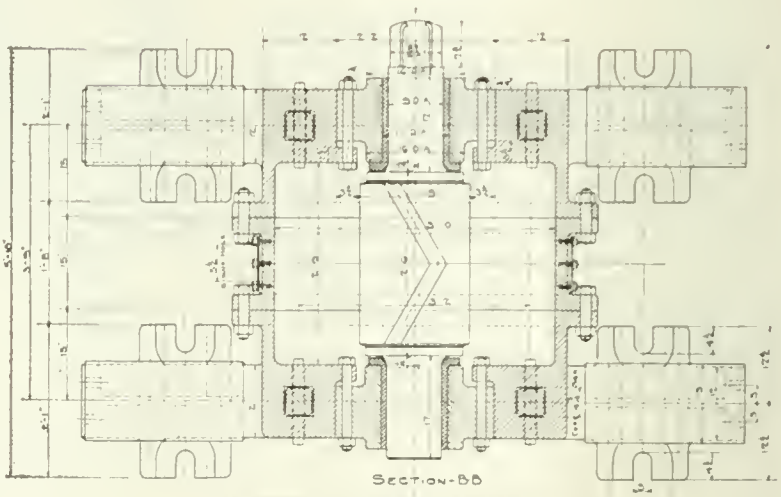
Fig. 33 is an assembly of the smaller open top housing when used as a 3 high bar mill. All the essential features of this mill are similar to the larger 3 high mill.

Fig. 34 shows an assembly of the pinion housing using three 16 inch cut herring bone pinions. This housing is of the enclosed type and has a filler piece 15 inches wide in the center, which is bolted to the two housings. If the face of the pinions is to be changed this filler may be widened or made narrower as conditions require.

The window of the housing is made sufficiently deep to permit the assembling of 18 inch pinions, or of using a 24 inch top and bottom pinion with a 16 inch middle pinion such as is used in the pinion housings of a great many three high plate mills.

In concluding the description of the experimental rolling mill in our next issue, some questions that are perplexing to rolling mill engineers at the present time, will be briefly outlined, and methods will be shown which have been provided for to study and solve these problems.

One of the most important problems that is to be discussed has to do with the power required to drive a rolling mill. Another has to do with the actual educational advantages offered by the Bureau of Rolling Mill Research.



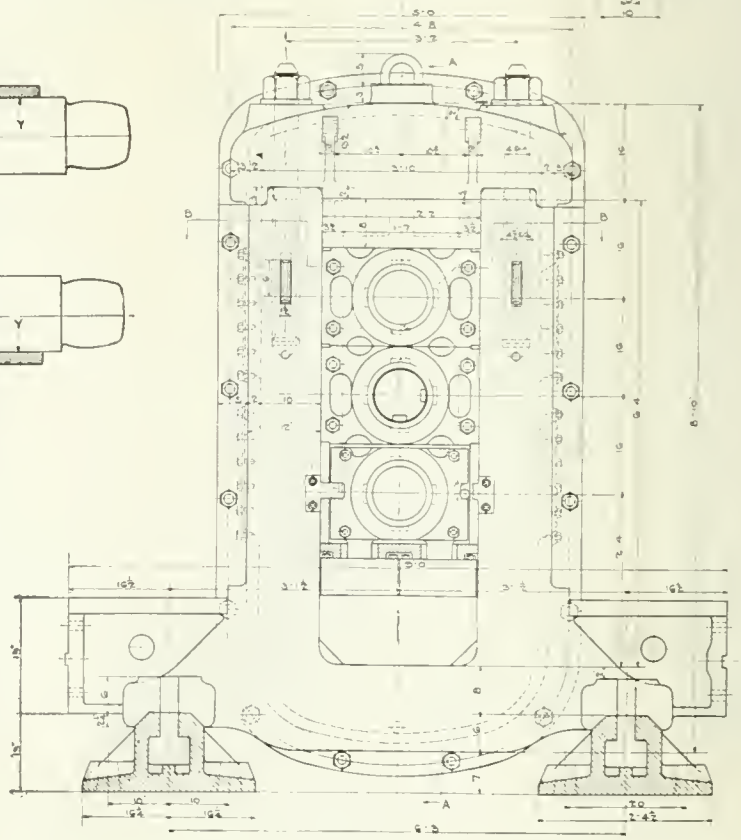


Fig. 34.

Improvements in Handling Ore and Coal

A General Description of Several Modern Installations for Handling Steel Plant Heavy Bulk Materials in a Cheaper and More Rapid Manner—Description of an Ore Unloader and a Car Dumper.

IN the past four years several factors have caused a stimulation of interest among shippers of heavy bulk materials in a cheaper and more rapid scheme of handling such commodities. The manufacturers of apparatus, especially the pioneers in this line, started a movement in this direction some 20 years ago, and succeeded in getting a limited number of plants installed as early as 1902. The development of plants for handling large tonnage of coal and iron ore was the most obvious necessity and it was naturally the first problem attacked on a large scale. The necessity for such development centered around the Great Lakes region and the pioneer installations were put in in this vicinity. The short season of navigation from the Minnesota, Wisconsin, and Michigan ore fields to the blast furnaces of the lower lakes and the Pittsburgh district, require a movement of 12 months supply of ore in about seven months. The coal supply of the states bordering on the iron ore region was largely taken from the lower lakes on the return trip of the ore boats. In order to perform this task with the minimum

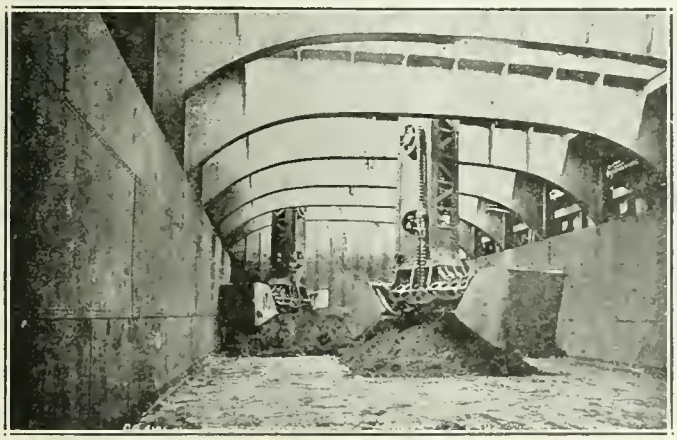


Fig. 1—View showing unloader, leg and bucket. The leg is so mounted in the walking beam that it can rotate in a circle, allowing the bucket to reach out in all directions.

of equipment and operating costs per ton, it was plainly necessary to provide machinery for cheap and rapid discharge of cargo from ship to dock or railroad and vice versa, the length of time the ship was tied up to the dock being a vital factor in costs. The result has been a high state of development and concentration of bulk cargo handling plants in the lakes region.

In the late nineties the Wellman-Seaver-Morgan Company brought out their ore unloader, each machine capable of handling ore at from 500 tons per hour upward. At about the same time the car dumper, for overturning standard railway cars and dumping their contents, was developed. The latter have been evolved until at present they will handle 30 dumps per hour and upward, some installations handling as much as 3,000 tons per hour of net material, two cars in tandem.

Conditions largely due to the European war caused a more general interest to be developed along our coast line in these methods. Prior to our participation in the war a few installations had been made on the Atlantic coast especially in the line of loading cargo and bunker coal. Rising labor costs and necessity of rapid "turn around" on the comparatively few vessels available brought the issue of improved dock facilities to the forefront. It was a question of time, tonnage capacity over a given water front, and cost per ton. All the above items in the problem are satisfactorily answered by equipment of the type previously mentioned, and what was still more vital the item of labor in normal volume being unobtainable at any price.

Two contracts recently secured by Wellman-Seaver-Morgan on the Atlantic coast are interesting at this time. A contract with the Lehigh Valley Railroad Company covers an automatic ore unloader carrying a 15 ton clam shell bucket on the unloader leg and designed to make a complete cycle or round trip in 50 seconds. The machine electrically operated throughout is illustrated by Fig. 1, accompanying this article. This view together with Fig. 2 illustrates the general appearance of similar apparatus in action.

The automatic unloader illustrated is unique in design and has proved through many years of service to be one of the most successful devices for unloading ore cargoes from steamers with suitable hatches that has ever been devised. Although of immense proportions, the design has been simplified and the control perfected to such a point that the machine is the last word in delicacy of control and operation.

The unloader consists of a main framework mounted on trucks which travel along the runway rails which are located approximately as shown in the photograph. The main framework extends back beyond the rear runway over a temporary storage pile where the ore can be discharged if desired. It is then picked up by the ore bridge and carried to the stock pile. Between the front and rear runways, space is provided for railroad tracks where ore carrying cars are placed under the machines and loaded with ore for transportation to the furnace plants. The girders of the main framework form a support for runway rails, on which a trolley travels. This trolley supports a balanced walking beam, from the outer end of which a stiff bucket leg depends. At the lower end of this leg is the bucket, which is operated by machinery located on the walking beam. All horizontal movements of the bucket are accomplished by means of moving the trolley backward and forward on the girders. The vertical movements of the bucket are accomplished by the operation of the walking beam. The forward portion of the beam being out of balance, the bucket descends by gravity as soon as the brakes of the hoisting mechanism are released.

Two operators are required for the entire operation of one of these machines. One of the operators, whose station is in the bucket leg directly over the bucket shells,

controls all of the motions of raising and lowering the bucket, of traveling the trolley back and forth, and moving the machine along the dock from one hatch to another. The second operator is stationed in a cab on the larry and from this station he controls the movements of the larry, the operation of the larry gates, and the weighing of the ore.

Some idea of the capacities of unloading by this method may be derived from a record which was made in Ashtabula by eight machines of this type having a capacity of 15 tons each, unloading seven boats having a total capacity of 70,000 tons in 22 hours actual time. At other points, four machines working in boats having capacities up to 13,000 tons have unloaded these cargoes in about three hours and 25 minutes.

In addition to the vertical movement, which is given to the bucket leg by means of the walking beam, it also has a motion of rotation around its vertical axis. This motion is introduced to enable the machine to reach along the keel of the boat and clean up ore between hatches. The distance from point to point of bucket shells when open is approximately 21 feet. About 97 per cent of the ore is removed from the boat without hand labor.

Records of 50 machines in operation indicate that this type of machine will handle ore at 2½ to 4½ cents per ton including all fixed charges, and records of as high as 783 tons of ore per hour per machine from tieup to castoff of boat have been made.

The Lehigh ore unloader will be installed at the Claremont Terminals, New York harbor to handle Chilean and Cuban ore. A cost of pig iron lower than that based on Minnesota ore is predicted due to economies effected.

A contract with the Western Maryland Railroad Company at Port Covington, Baltimore, covers a Wellman car dumper to handle 100 ton road cars. It is the first electrically operated lifting dumper for seaboard coal loading to be negotiated. The lifting feature is designed to raise the road car high enough before overturning to cause the coal to run down the apron and chute into the ships hold. Dumping directly to the ship eliminates breakage and waste due to rehandling. The entire cargo is trimmed without the use of hand labor.

The machine consists essentially of a rectangular framework supporting a rotating cradle in which the loaded railroad car is held while discharging. An entirely automatic counterweight device clamps the car to cradle which is inverted by the revolving mechanism, carrying the car with it. The top of the cradle forms a chute for directing the material as it flows out.

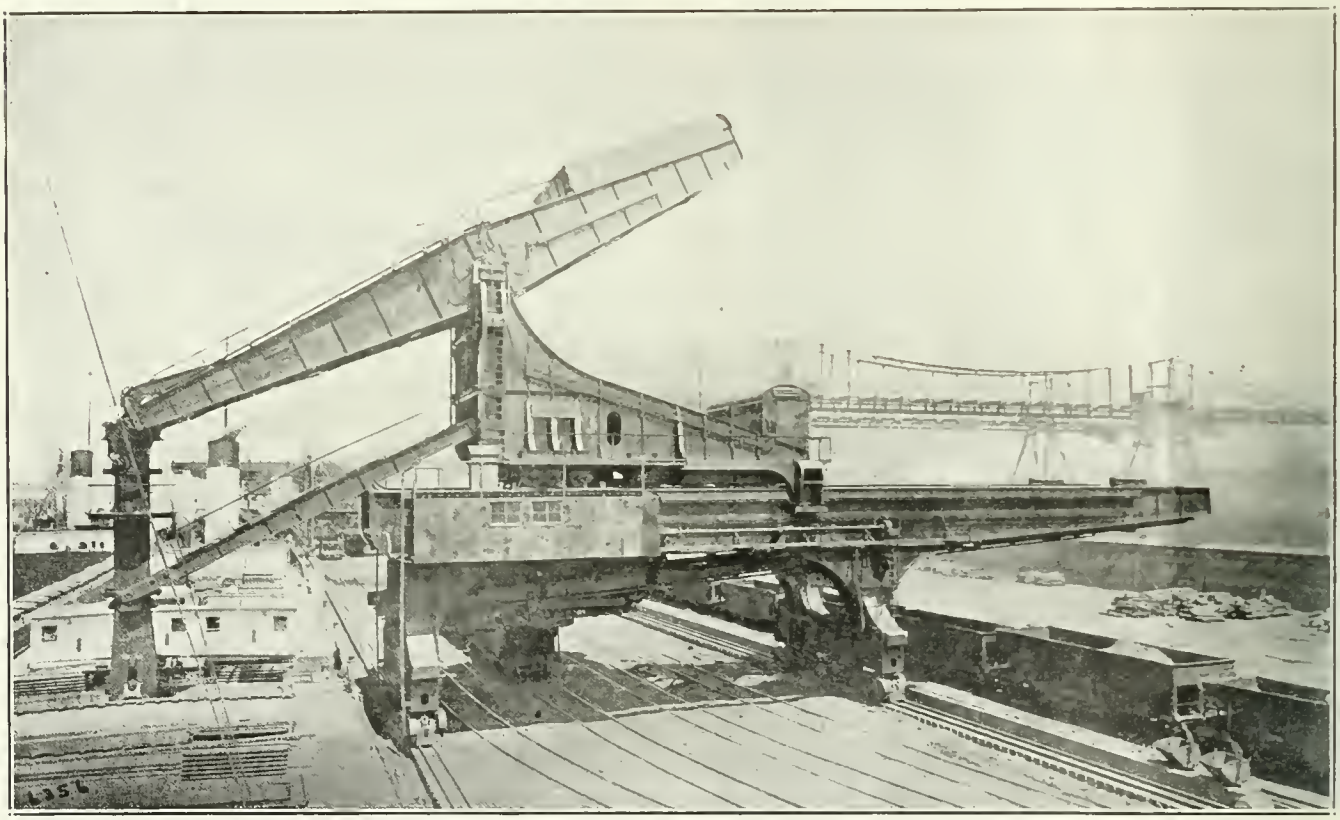


Fig. 2—Unloader used at dock of United States Steel Corporation at Conneaut, O. Seven similar machines are used at these docks.

This installation will have a nominal capacity of 30 to 45 cars per hour of cargo and bunker coal, principally for export. The coal is delivered to the dumper by the Western Maryland Railroad from the West Virginia, Virginia and Pennsylvania fields. One million tons will be handled annually with a probable increase to twice that capacity later.

These typical plants indicate the essential soundness and progress of our basic industries, and the gradual elimination of hand labor, which is then diverted to more useful and productive work. These plans also indicate that beneath the surface froth of labor unrest and business uncertainty of the day, that there is a constant current of accomplishment and confidence. The former are merely the phenomena of a business cycle and the latter is the foundation of the country.

The Manufacture of Merchant Bars

Description of the Processes and Mill Required in the Production of Merchant Bar at the Youngstown Sheet and Tube Company Plant, Youngstown, Ohio.

By A. E. JUPP.

THE product known as merchant bars is one used for countless purposes, thousands of articles being fabricated from this form of steel. The name comes from the fact that these bars were originally sold to merchants and by them disposed of to blacksmiths and other small users. The name has not been changed for 250 years, although originally there was little or no steel made in this form, bars being always made of iron.

Our merchant mills began operation in 1917. They take billets and small slabs rolled on other mills and form them into bars. The operation begins at a temperature of 2,200 degrees F.

Some sections and sizes require many passes through the rolls, others not so many. After the steel is rolled to the right size and shape, it passes to cooling beds, where it is slowly cooled in such a way as to prevent warping, and when this is done the bars pass on to shears, on which they are inspected,, weighed, and loaded on cars for shipment.

We have two merchant mills, built by the Morgan Construction Company, Worcester, Mass. The 12-inch mill is designed to take billets 1¾ to 3½, slabs 4x2 to 5x2, 30 foot lengths, and reduce them to finished sections of ⅞ to 2-inch rounds and squares, flats 1½ to 4½ and angles 1½x1½ to 3x3.

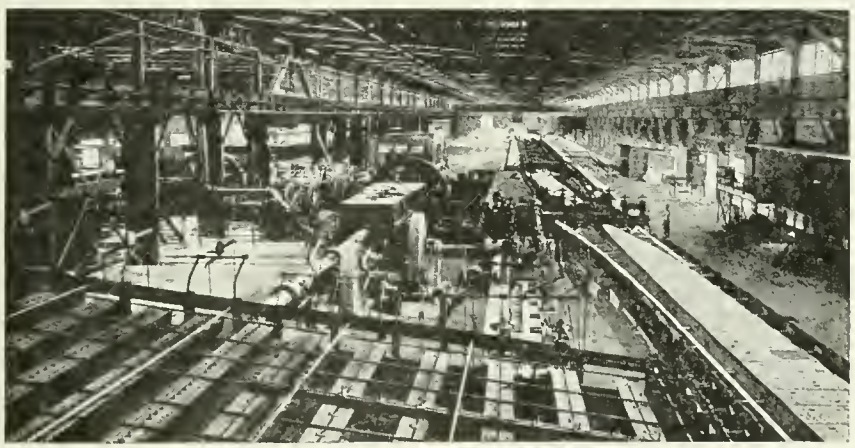


Fig. 1—Twelve-inch merchant mill.

The capacity under normal conditions is 10,000 tons per month of average sections.

The 12-Inch Mill.

The 12-inch mill building is 100 feet wide by 1,150 feet long. One 15-ton single-hook crane serves the mill, and one 15-ton double-hook crane is used for stock handling. The buildings are of steel construction, and with the exception of the billet yard, have Pond type roofs, with swinging windows of steel sash and operating device. The roughing mill is a five-stand continuous train of 14-inch rolls, with an electrically driven dividing shear placed midway between the No. 2 and No. 3 stands. The four-stand 12-inch finishing mill is made of two trains arranged in pairs of two stands each, placed in a staggered position to one side and in front of the roughing mill. These roughing and finishing trains are driven by a Nordberg 44x50-inch uniflow engine of the poppet valve type, running from 65 to 100 rpm and developing up to 2,100 brake hp.

The cooling bed is 300 feet long, and is of the double universal type. Located at the end of the bed, and on each side are the roll straighteners of special design, having all driving gears mounted in oil-tight dust-proof housings, and without gears on the ends of the straightener rolls. Beyond the straighteners are located the 300-feet long front shear tables, bar shears, 75 feet back shear tables and scales where the material is sheared to desired lengths and weighed before shipping or stocking. A scrap shear is located near the mill end at the side of the cooling bed, while at the south end of the building in the rear of the back shear tables and scales is located a cross roll straightener for straightening rounds.

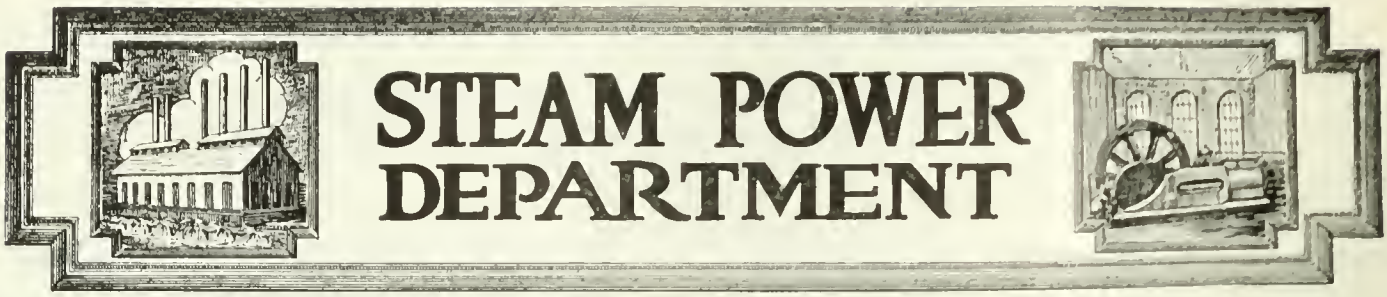
Electric current for operating the transfer tables, cooling bed, etc., is generated at the rod and wire power house. All control apparatus for operating the motors in this mill is concentrated in two control houses centrally located with respect to the motors.

The 9-Inch Mill.

The 9-inch mill was also built by the Morgan Construction Company, and is designed to take billets of 1¾x1¾ inches to 2¼x2¼ inch sections, in 30-foot lengths, and reduce them to finished sections of 11/32 to ⅞ inch rounds and squares, flats up to 2½ inches wide and angles up to 1½x1½ inches, with a capacity under normal conditions of 6,000 tons per month of average sections. The main 9-inch mill building is 90x1,175 feet, with a 24x600 foot shipping platform on the north side for the storage and shipping bundles. One 15-ton single-hook crane serves the mill, and one 15-ton double-hook crane is used for stock handling. The roughing mill is a six-stand continuous train of 12-inch rolls, with a steam-operated double-knife dividing shear in front of the No. 1 stand and a 30-foot side looping table between No. 2 and No. 3 stands, the shear and looping table are arranged for operating mill either single or double strand. This train is driven by a Nordberg 37x48 inch uniflow engine of the poppet-valve type, running from 65 to 110 rpm, and developing up to 1,500 hp. The six-stand finishing mill is made up of three independent sets of two stands each, placed in a staggered position to one side and in front of the roughing mill. Each set has an

(Continued on Page 515.)

Taken from Youngstown Sheet and Tube Bulletin.



Blast Furnace Gas Used Under Boilers

Progress Made in Getting Greater Efficiency Out of Blast Furnace Gas When Used Under Boilers—Good Efficiencies on Old Type Burners.

By F. J. DENK.

UNTIL a comparatively recent period, progress in burning blast furnace gas economically has been slow. One of the reasons for this condition was, on account of the low price for coal, it was thought hardly worth while to bother about this fuel. But it was also believed that hot, dirty blast furnace gas was not a good fuel for boilers. Efficiencies of 60 per cent were considered an excellent performance, 40 to 50 per cent being the rule. The reasons for their conditions were due partly to the crude design of the "burners," which, in many cases, were nothing but a piece of pipe

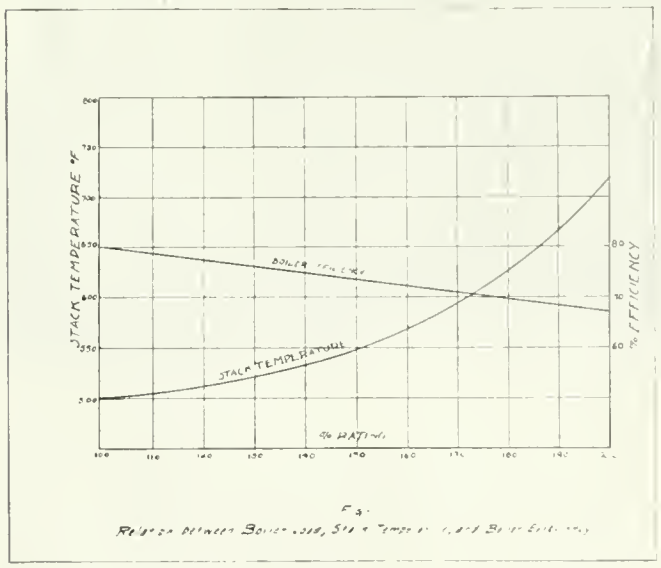


Fig. 1.

with no provisions for gas and air mixture, and partly to the type of boilers in use at that time.

The question of right design and type of burners for using blast furnace gas has been treated several times in this paper as well as in other magazines, and for this reason, this subject will not be dealt with here. The influence of construction of the boiler proper has not been given much thought in the technical press and it may, therefore, be well to illustrate a few points, which tend to show how high efficiencies and high overload can be obtained, even with blast furnace gas.

One pass boilers of the Cahall, Wheeler and similar types were used to a large extent. With these boilers, the application of modern combustion arrangements will result in high efficiencies at rated capacities, with overload, however, high efficiencies cannot be obtained with blast furnace gas as fuel, for reasons given below. Return tubular boilers are not suited for uncleaned gas, because the dirt will settle in the fire tubes and efficiencies and loads will decrease steadily until, after about one week's operation, the boiler will have to be shut down and cleaned.

Conditions are entirely different with water tube boilers having more than one pass, and it can be said that, all other conditions being equal, the number of passes is of great importance on the efficient working of a boiler fired with blast furnace gas.

The flexibility of a modern water tube boiler is very great and high efficiencies have been obtained and are obtained with such boilers, even when highly overloaded, provided the combustion arrangements are uptodate. There is, however, a limit to overloading and this limit is reached mostly for loads lying between 165 and 180 per cent of the rated capacity. This limit depends on the contents of dust in the gas, which settles on the tubes, thus interfering more or less with the transmission of heat through the tubes. As soon as it is no longer possible, to remove the dust once every turn in an economical way, overloading should not be increased any further.

The efficiencies of boilers, fired with blast furnace gas, depend, besides on good combustion arrangements, on some conditions which cannot be or are not controlled under ordinary working conditions. For instance, the amount of water vapor in the gas has a considerable influence on the efficiency; there may, furtnermore, be a varying gas pressure in the line, which may increase or decrease the amount of gas available per unit time for the boilers. The air excess also influences the efficiency, but this latter item can be regulated so as to give good results. A certain quantity of excess air is always necessary, because the mixture of gas and air is hardly ever sufficiently intimate, to insure a complete combustion, unless there is present an excess of oxygen. For this reason the gas should never be burnt with less than between 5 and 10 per cent excess of air because the variation in the combustion of the gas makes the danger of incomplete combustion too great.

For the reasons stated above it is hardly possible, to

calculate exactly the efficiencies for high overload and the corresponding stack temperature. The curves, shown in Fig. 1, give the relation between per cent overload, boiler efficiency and stack temperature. They have been taken from actual tests, made on gas fired standard 3-pass Stirling and B. & W. boilers, and have been checked theoretically. It can be seen that the efficiency drops steadily with increasing overload. As was stated above, a limit is reached at about 165 to 180 per cent load, due to the contents of dust in the gas. But there is something else, which may influence the efficiency. Assuming a regular working of the blast furnace, the gas generated has a certain composition and temperature, and, therefore, heat value, and enters the combustion chamber with a certain pressure. It may also be assumed, that a gas with such qualities is able to generate 140 per cent overload with an efficiency of 75 per cent. Now, an increase in the percentage of the overload can only be obtained by increasing the heat units and this, in turn, can only be done by increasing the quantity of gas admitted into the boiler per time (or any other) unit. Therefore, forced draft has to be applied. But, when

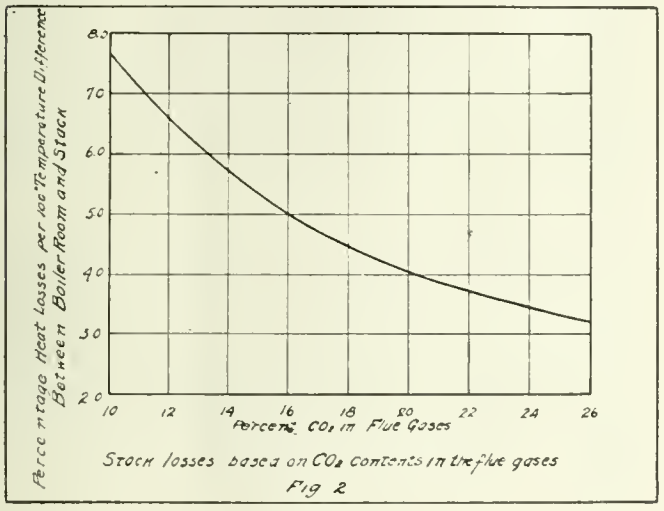


Fig. 2.

the quantity of the gases is increased, the velocity, with which they go through the passages, will increase, thus diminishing the chance for heat transmission. Besides, the mixture of gas and air may not be intimate enough to produce complete combustion on account of the velocity with which the gases are going through the combustion chamber. The first condition increases the final temperature of the stack gases, while the second condition causes incomplete combustion; in both cases the stack losses are increased and the efficiency of the boiler is decreased. The boiler efficiency curve (Fig. 1) would, consequently, have the tendency to drop down with a higher rate than is shown and would, for instance for 200 per cent load, approach the 60 per cent mark.

Increasing the number of baffles, i.e., increasing the length of the travel of the gases, will remove the disadvantages, connected with the application of forced draft. The longer passageways will allow a more complete heat transmission, thus enabling the hot gases to give up all the heat, necessary to evaporate the increased amount of water. If, then, complete combustion is insured, the conditions are such, that high overloads can be carried with good efficiencies. It may thus be possible, under favorable conditions, to increase the boiler efficiency for double load to 70 per cent. Clean tubes and tight boiler settings form the fundamental base for such favorable conditions.

Another point which has to be kept in mind, when designing boilers for blast furnace gas, is the size of the combustion chambers. From tests made for the purpose of determining the right length of the combustion chamber to insure complete combustion it has been found, that the overall efficiency was increased about 11 per cent when the combustion chamber was shortened. This is no doubt, due to the elimination of eddy currents, which had formed in the long chambers, thus giving the gases a chance to give up some of the heat, before they reached the tubes. The tests were made on standard B. & W. boilers.

Even with the most uptodate boiler low efficiencies may be obtained, when the boiler is not taken care of in the right way. But before the subject will be discussed, it may be well to mention a few words in regard to the difference between using clean gas and raw gas.

A number of tests have shown, that one advantage gained by using clean gas is the uniformity of quality and pressure of the gas, due to the blast furnaces being connected into one main and the pressure being controlled by the gas cleaning plant, thus making it possible to set the gas valves at the boilers to burn just the necessary volume of gas. There is also a saving in labor and delay in boilers which is due to the practically total absence of dust in the washed gas, therefore, dispensing with the necessity of stopping the boilers for cleaning out dust, which condition cannot be entirely avoided when burning rough gas. These advantages, however, are counterbalanced, either entirely or at least to a large extent, by some disadvantages, connected with the application of clean gas. The first one is the loss in sensible heat of the gas due to washing. Although the opinion has sometimes been forwarded, that cold, clean gas deserves preference over hot, rough gas, this opinion cannot stand investigation. It is true, cold, washed gas will do the same work as hot uncleaned gas of the same condition, if used in recuperative or regenerative furnaces, but a boiler furnace is no regenerative furnace and a drop in temperature from 450 degrees F. to 100 degrees F., which is about the difference between the temperature of raw gas and washed gas, will be followed by a drop in the temperature of combustion. The loss of sensible heat on account of washing is, therefore, a net loss which cannot be recovered. It is true, when boilers are operated with low efficiencies, a gain may be shown when using clean gas. The writer has data from a series of tests made to determine the difference in efficiency for raw gas and for clean gas. In the first case an average of 598 cubic feet of gas were required to develop one boiler horsepower, in the second an average of 533 cubic feet, or a difference of 65 cubic feet. This meant an increase in efficiency from about 50 per cent to about 60 per cent. All conditions at the time, when these tests were made, facilitated the gains, but it is very doubtful, that with a modern equipment, giving 75 to 80 per cent efficiency, the results could be repeated. It is safe to say, that under modern conditions no increase will be shown. A further disadvantage in using clean gas is the increased cost of washing apparatus.

As was stated before, low efficiencies may be obtained even with the most uptodate boiler. The causes for such conditions are low combustion temperature and the human element. Every gas has a certain highest temperature of combustion, which is obtained when it is dry and when it is burned with the least amount of air

required for complete combustion. Excess of air, deficiency of air, moisture in the gas will reduce the temperature of combustion. As blast furnace gas has the lowest flame temperature of all industrial gases, viz.: about 2,500 degrees F. or somewhat less according to the composition, it must be the aim of the engineer in charge, to keep his temperature in the furnace as close as possible to the theoretical one. From the temperature of combustion depends the temperature of the stack gases, provided the furnace and boiler are in otherwise good condition, because high temperature in the furnace means good combustion. Good combustion, in turn, is indicated by the amount of CO_2 in these flue gases and this CO_2 again determines the stack losses.

Fig. 2 shows the percentage losses through the stack gases. The curve is based on an original Co_2 contents in the blast furnace gas of 25 per cent and also on the condition, that there are no combustible gases present in the flue gases, which increase the stack losses. Supposing, for instance, a flue gas contains 23 per cent CO_2 and no CO at a temperature of 500 degrees, when the boiler is running at its rated capacity (the figures are taken from actual tests); the curve then gives 3.7 per cent loss per

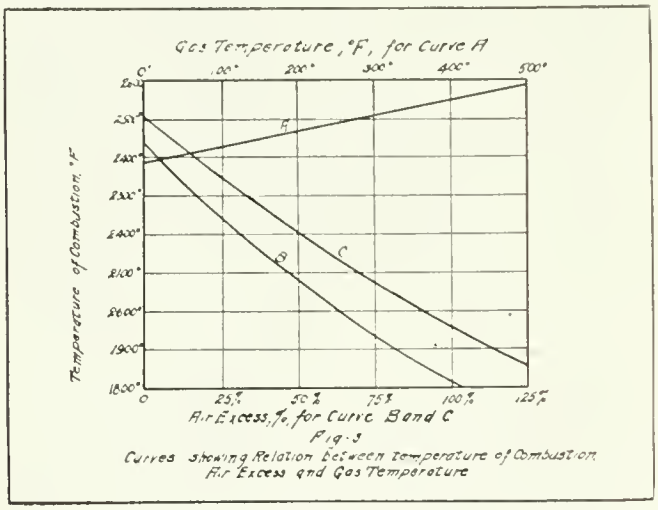


Fig. 3.

100 degrees temperature difference. Assuming 80 degrees from the boiler room temperature, the difference is 500 —80 = 420 degrees F. Then, 4.2 × 3.7 = 15.5 per cent. Assuming, furthermore, a radiation loss of about 5 per cent, a total loss of 20.5 per cent will result, which gives 79.5 per cent boiler efficiency, i.e., practically the same as shown on the curve in Fig. 1 (80 per cent). Thus the boiler efficiency can easily be obtained, provided good combustion prevails, by simply making a flue gas analysis and a temperature determination of the stack gases. If CO should be present in the flue gases, this would show incomplete combustion, the causes for which would have to be removed after careful investigations have revealed them.

Fig. 3 illustrates the corelation between original gas temperature and theoretical temperature of combustion (Curve A) and between the percentage of excess air and the theoretical temperature of combustion (Curves B and C). Curve A shows how the temperature of combustion increases with the original gas temperature. It is calculated for dry gas and proves the statement made above, that washing gas will decrease the efficiency. We can see, that for a temperature of 450 degrees F., which is about the temperature of raw gas, the temperature of combustion is 2,570 degrees F., while for a gas temperature of 100 degrees F., i.e., the temperature of the washed gas, the temperature of combustion is 2,430 degrees F., or a drop of 140 degrees F. This can still better be seen with Curves B and C. Curve B represents washed gas, dry, with a temperature of 100 degrees F. while Curve C represents raw gas with a temperature of 450 degrees and a moisture content of 40 grains per cubic foot. These are about the actual conditions of the two gases. We see, that, with 10 per cent excess air, the temperature difference is 90 degrees, 2,440 degrees F. for Curve C and 2,350 degrees F. for Curve B, which again proves, that washing the gas will reduce the temperature of combustion. Curves B and C also show plainly the influence of excess air on the combustion temperature and explain partly, why with the old type of boilers efficiencies over 50 per cent were seldom obtained. The reason was, at least to a certain extent, a high excess of air, due to leakage in the boiler settings, frames, etc. Here it is, where the human element comes into consideration. With our modern burners, which are scientifically designed, good results can only be obtained when the men in charge of the boilers are conscientious and careful. If the boilers are not watched, leaks not closed up, no burner will and can work efficiently, no matter, how well it is designed. A good prevention of leaks in the setting is a good coat of insulating paint, applied to the boiler from time to time. The leaks in the door frames or around manholes can be closed up with asbestos packing. There is no reason for conditions of this kind, which show only carelessness and inattendance on the part of the men in charge of the boiler plant.

Good efficiencies can be obtained even with the old type Bunsen burners if only efficient men are employed, but careless operators can more than offset the work of the most efficient burner. It is, therefore, of the utmost importance in a boiler plant, and this holds good not only for gas fired boilers, but also for coal fired boilers, that only efficient men are employed and that these men know that they are watched continuously otherwise the efficiency of the boilers will drop down which will result in losses of fuel and, therefore, money.

ORGANIZE SECTION OF WELDING SOCIETY.

At a meeting of members of the welding trade in Chicago, held in the rooms of the Western Society of Engineers on Tuesday evening, August 3, a Chicago section of the American Welding Society was organized. There were about 75 in attendance, representing railroads terminating in Chicago, and local industries. The following officers and directors were elected:

Chairman, M. B. Osburn, assistant superintendent, Pullman Company, Pullman, Ill.; vice chairman, O. T. Nelson, president, General Boilers Company; secretary-treasurer, L. B. Mackenzie, president, *Welding Engineer*, 608 South Dearborn Street, Chicago. Directors: E. Wanamaker, electrical engineer, Rock Island Railroad; H. B. Bently, superintendent motive power and machinery, Chicago & Northwestern Railroad; Andrew Oliver, welding supervisor, Standard Oil Company; W. M. B. Brady, commercial engineer, General Electric Company; Harold Cook, managing editor, *Acetylene Journal;* W. A. Slack, president, Torchweld Equipment Company; K. R. Hare, district manager, Transportation Engineering Company; J. M. Jardine, Western Welding & Equipment Co.; W. H. Bleecker, Jr., district manager, Page Steel & Wire Co.; Oliver Mitchell, A. F. Mitchell & Son; Walter L. Senhert, president, Welded Products Company; Don B. McCloud, secretary-treasurer, Gas Products Association.

Discussion in the Use of Powdered Coal

Conditions Justifying Its Use—Cost of Installation—Cost of Handling—Thermal Efficiency—Combustion—Furnace and Flue Gas Temperatures—Radiant Heat—Non-Combustible Matter—Safety.

By JOHN E. MUHLFELD.

THERE is probably no other engineering subject on which has been presented so much data, based on speculative and deductive reasoning, as that of powdered coal; and the time has now arrived when such information—including much misinformation—should be supplanted by conclusions based on specific knowledge gained from the results of actual practice.

The facts that about one-half of the earth's known coal resources—or over three and one-half trillion tons—lie in the United States, and that this country annually mines about 40 per cent of the world's coal production, give evidence that we will depend largely upon its use for power, heat, and light for many years to come. Therefore, any method that can be devised to utilize this fuel of the present and the future in a way that will better provide for the necessities, health, and comfort of human life—and at the same time in a more effective and economical manner—is deserving of every consideration, particularly now that its average quality is decreasing and the cost of its production and distribution is increasing annually.

Ask any man behind the furnace, whether it be for steam generation or metallurgical or chemical heating purposes, whether he prefers a fuel of equivalent heat value that can be burned in suspension—that is, gas or oil—or one that can be burned on grates or in retorts—that is, coal, coke, lignite, or wood—and, if he has had experience with both, he will invariably be in favor of the former. For this opinion there are many good, practical reasons which, regardless of the important factor of conservation, fully justify the use of solid carbonaceous fuel in powdered form.

However, so much has been presented on the subject of powdered coal in the way of glittering generality, unsupported by authenticated records, that self-protection compels the statement that the burning of solid fuels in suspension is not yet the solution of every combustion difficulty. My personal experience during the past 25 years with the use of gaseous, liquid, colloidal, and powdered and lumpy solid fuels for stationary, locomotive, and marine boiler and heating furnaces leads me to present, at this time, the following conclusions:

1. Decision regarding the substitution of powdered anthracite, bituminous coal, lignite, or peat for any other fuel should be reserved until a careful, unbiased, expert analysis has been made of the comparative costs. This analysis should include installation, interest, depreciation, taxes, insurance, operating and upkeep expenses, from the source of fuel supply to the stack.

2. No system of powdered fuel drying, milling, storage, distribution, feeding, or burning should be considered for a permanent installation unless it provides for the prime necessities of proper fuel preparation and handling correct firing and furnace design, and satisfactory operation; and unless it has demonstrated, in actual operation, its adaptability, practicability, safety, efficiency, and economy with the fuel to be used, for the kind of service required.

Abstract from paper presented by Mr. Muhlfeld vice president, Railway and Industrial Engineers Inc., New York, before June meeting of Engineers' Society of Western Pennsylvania.

Conditions Justifying the Use of Powdered Coal.

In general, the factors justifying the serious consideration of the use of powdered coal may be stated as follows:

1. Daily consumption of 80 tons, or more, of average commercial coal, or other solid fuel equivalent, from one preparation plant.

2. Necessity for greater output from existing equipment.

3. Available supply of cheap low-grade fuel.

4. Special operating requirements, such as irregular and peak loads; exacting character (neutral, oxidizing, or reducing), length of direction of flame; and excessive banking and standby periods.

5. Advisability of reducing the human element factor, particularly as relating to arduous non-productive labor.

6. Desirability of minimizing fuel and labor, both of which are expensive.

7. Expensive ash-handling, and boiler and furnace upkeep.

8. Necessity for reduction of smoke, soot, sparks, and cinders.

9. Available gaseous, liquid, or solid fuels for use in the same furnaces in combination or independently.

It is of interest to note the comparative purchasing power of one cent with various fuels based on their heat values at the furnace. This comparison is presented below:

Powdered Bituminous Coal.		
Btu per pound		12,000
Btu per ton		24,000,000
Cost per ton (including handling, pulverizing, and transmission to furnace		$5.50
Btu for one cent		43,636
Natural Gas.		
Btu per cubic foot		960
Btu per 1,000 cubic feet		960,000
Cost per 1,000 cubic feet		$0.25
Btu for one cent		38,400
Producer Gas.		
Btu per cubic foot		130
Producer efficiency, per cent		78
Cost of coal	$4.95	
Cost of labor	0.65	
Cost of power	0.40	$6.00
Btu available in gas from one ton of coal (12,000 Btu per pound of coal)		18,720,000
Btu for one cent		31,200

Fuel Oil.	
Btu per pound	19,000
Pounds per gallon	7.3
Btu per gallon	138,700
Cost per gallon	$0.09
Btu for one cent	14,411

In view of the foregoing, the equivalent fuel cost values are as follows:

Powdered coal at $15.56 per ton equals oil at 9 cents per gallon.

Powdered coal at $7.65 per ton equals coal for producer gas at $4.95 per ton.

Powdered coal at $6.25 per ton equals natural gas at 25 cents per 1,000 cubic feet.

Coal for producer gas at $10 per ton equals oil at 9 cents per gallon.

Coal for producer gas at $3.83 per ton equals natural gas at 25 cents per 1,000 cubic feet.

Practical operating results at a power plant using both powdered coal and fuel oil have proved that the increased efficiency from powdered coal—probably due to the radiant effect of the ash in suspension in a boiler furnace—is sufficient to offset the actual increased cost of pulverizing, handling, and firing of solid fuel as compared with the cost of firing fuel oil. Thus the comparative cost can be considered on a Btu basis, irrespective of the amount and character of the ash, which, in the ordinary practice of firing, makes it difficult to maintain combustion, and which decreases so largely the overall efficiency of the combined furnace and boiler.

Take a specific instance, with run-of-mine bituminous coal of about 12,500 Btu content per pound, costing $3.75 per ton, and fuel oil of about 19,000 Btu content per pound, costing 90 cents per barrel, both delivered alongside the power plant. The heat value purchased per dollar would be 6,666,666 Btu for coal, and 6,561,333 Btu for fuel oil, and the net operating result, in terms of cost for steam produced shows a slight difference in favor of the powdered coal.

Cost of Installation.

Until the world war, the United States had been particularly fortunate by reason of its readily accessible deposits of thick-vein, high grade anthracite and bituminous coal. This coal could be mined with relatively low cost for labor and could be distributed to consumers at the lowest transportation cost in the world. However, with the annual depletion of the thick-vein coal, the higher cost for propping, haulage, pumping, lighting, ventilation, and powder used in mining, the advancing labor wage scale, and the necessarily increased freight rate, the item of fuel cost has increased from two to three times its former value and has become a proportionately increased percentage in the operating costs of railroads, public utilities, and industries. During the same period that fuel costs have increased so enormously, interest rates have increased only from an average of 5 to 7, or about 40 per cent.

Therefore, an installation and annual fixed charge cost, that would have been prohibitive a few years ago, for converting equipment to the use of powdered coal, is, through the large operating savings now possible, made not only permissible but in many cases a necessity, if protection is to be afforded to the transportation and industrial corporations that are at present and will be in the future affected by high fuel costs.

Cost of Handling and Preparing Coal.

The plant required, the investment and fixed charges, and the expense of preparing a ton of coal, preparatory to burning it in powdered form, have been the principal factors in retarding its more general use for steam generation and heating furnace purposes.

From the appendix, the following items have been taken:

No.	Item	Powdered coal	Stoker
71.	Total cost of preparation, per ton prepared	$0.3325	$0.009
83.	Total cost of handling in distributing system per ton	0.0440	0.0494
99.	Total cost of boiler firing, per ton fired	0.5376	0.7933
100.	Total cost of preparing, distributing, and firing coal, per net ton	0.9141	0.8517

The foregoing figures include the cost for fixed charges, power, maintenance, lubricants and labor required for handling a ton of coal from alongside the plant to the stack and the disposal of its ash. When all these factors are included, the difference between the cost per ton for preparing and putting either—the powdered and stoker fired coal—through the furnace, is not as great as is generally supposed. Furthermore, considerable reduction can be made in the present cost and complexity of the preparing plant and distributing equipment for powdered fuel. Much of that now sold and used is most extravagant in the cost for maintenance as well as in the use of power for its operation.

Then, too, the determination for each kind of fuel used, as to the proper dryness and fineness required for the best overall results, is an important preparation cost factor that has received too little careful analysis. Very frequently it has been found that extremely fine grinding is unnecessary, and that little or no mechanical drying is required for satisfactory results. This depends, of course, upon the character of the fuel and of the conveying, feeding, and burning equipment used. For example, I know of a steel plant near Pittsburgh where the coal is conveyed direct to an air separation type of pulverizer and, without mechanical drying, is very successfully used in re-heating and stationary boiler furnaces.

Thermal Efficiency.

The value of "combined efficiency," which is generally used as a basis for comparing the performance of different methods of firing furnaces, is somewhat questionable unless all conditions are known and understood and accompanied by the "heat balance." For example, a 98 per cent furnace efficiency in combination with a tea kettle, which due to design and conditions could not absorb the heat offered to it, would produce a very poor "combined efficiency" as compared with an 85 per cent furnace efficiency in combination with a first class boiler.

There is no question but that, with certain powdered coal equipment and boiler furnace combinations, from 98 to 99 per cent of the combustible fired is reduced to CO_2. To secure the absorption of the heat so generated by the boiler, however, is something outside the province of the combustion engineer. With various types of steam generators there has been no

difficulty in keeping from one to five boilers operating continuously for from 24 to 96 hours, at from 125 to 200 per cent ratings; combined efficiencies of from 78 to 85 per cent, gross; and from 75 to 81 per cent, net; this difference between the gross and net being due to a reduction on account of the evaporation from boilers necessary to provide power for crushing, handling, drying, pulverizing, and firing the powdered coal.

Combustion.

It is a relatively easy matter to prepare and burn powdered fuel, but the erroneous idea that an ordinary furnace, equipped with a common blast or induction inlet into which fuel can be fed as a predetermined admixture of air and fuel or by a piece of gas pipe fitted with a feed screw, will produce a proper degree of capacity, efficiency and economy, has resulted in many otherwise avoidable failures and delays.

The justification for burning solid fuel in powdered form is that when reduced to the proper dryness and fineness for its character, and handled in a manner to prevent the re-absorption of any considerable moisture, it will produce a quick chemical reaction or combustion when passed, in suspension, through a relatively high-temperature furnace zone containing free oxygen; and will not be affected by any lack of temperature transfer through the fuel particles, or by intervening non-combustible between the combustible and the free oxygen.

Therefore, to burn powdered coal effectively, all necessary air must be supplied to the combustion zone, progressively, by induction. This is to enable the expansive action of the gases in that zone, resulting from the great affinity between the carbon or carbonaceous gases at high temperatures to set up a circulatory motion and enable each particle of combustible to come into intimate contact with the requisite oxygen for complete chemical reaction, the gases displacing surplus air and more or less automatically regulating the supply of oxygen. When air is forced into the combustion zone under pressure, it must necessarily be in predetermined quantities in relation to the Btu in the fuel supply (if complete, efficient combustion is to take place) and such regulation is practically impossible.

The process of chemical reaction having been completed, such combination of air control and flame travel must then be provided as will insure proper control of the temperature as well as the conversion of the highly radiant liquid non-combustible to low-temperature dry particles. This is effected by passing through a neutral air zone, for absorption of heat and to prevent the reduction of ferric sulphide to ferrous sulphide. This latter reduction is the direct cause for the formation of honeycomb as well as troublesome molten slag.

Frequent reference is made to the high CO_2 obtainable with powdered fuel firing, whereas it is a well known and accepted fact that the percentage of CO_2 in the gases is only indirectly a measure of furnace efficiency. Furthermore, when the average CO_2 at the stack goes beyond 15 to 16 per cent, dependent upon the character of the fuel, trouble from molten slag commences.

Powdered fuel undoubtedly offers the best means of getting high furnace efficiency from low-grade fuels. Those of high volatile content, when grate or retort fired at any but low rates, always lose a large proportion of the gaseous combustible to the stack, unconsumed. This is due to the considerable volume liberated, and the impossibility of proper mixing over the fire—such as is obtainable with powdered fuel. Likewise, fuels of low volatile content, when burned in powdered form, can be made to produce excellent results through regenerative action, with proper furnace design.

Again, with all low-grade coals and lignites, it is practically impossible to burn them in a lumpy form and maintain combustion conditions over any considerable period of time; or to maintain a fire-bed of equal thickness without clinker or air holes. As fuel burned on grates or in retorts is a combination of a gas-producer and a gas-burning chamber, much of the heat of the high-temperature non-combustible is lost by the heat-absorbing surfaces, due to its being carried away into the ashpit, etc.

Furnace and Flue-Gas Temperatures.

Temperature, as the result of combustion, is affected by excess oxygen, excess nitrogen, and time. While these three elements are all factors which enter into the control of furnace temperatures, none of them has any material effect on any particular loss of the useful heat available for work, when regulated to control temperature.

The refractory which is essential for primary combustion and regenerative action in a furnace for burning powdered fuel, is the limiting factor as regards the obtainable and permissible temperatures. In ordinary heating furnaces, where the exposed heat-absorbing surfaces are relatively small, there is no difficulty in producing and regulating temperatures of from 3,100 to 3,200 degrees F. In locomotive-type boiler fire-boxes, where a large area of heat-absorbing surface is exposed to combustion, temperatures of from 2,600 to 2,800 degrees F. are easily regulated and maintained.

However, to control these temperatures properly, and produce efficient results with powdered fuel, requires not only proper furnace design and equipment, but also certain arrangements for fuel feed, burner, primary and secondary air supply, and draft. With these, it is a relatively easy matter to maintain a uniform temperature of the desired degree for any period of service, or to increase or decrease it within the working range at will.

With respect to flue gas temperatures, these are generally no higher than for other fuels and methods of burning. This is due largely to the fact that powdered fuel requires less excess air for complete combustion. Therefore, the products of combustion have a higher heat value per cubic foot of furnace volume, with the result that less gas must be conveyed to and through the heat absorbing surfaces to produce a given heat result. This permits of a deduction in the velocity of the gases from the furnace to the stack, and the absorption of a greater amount of heat from these gases.

Under certain conditions, where flue-gas temperatures from powdered fuel may be higher than from coal burned on grates or in retorts, due consideration should be given to the fact that these gases carry in suspension impalpable particles of ash that have a higher specific heat value than the gas itself. These

ash particles act as an effective medium for the transfer of heat. They increase the Btu value of each cubic foot of gas passing through the furnace or steam generator to the stack; whereas, in stoker practice they pass from the fire chamber to the ashpit, where the heat is entirely lost.

Radiant Heat.

When solid fuels are burned on grates or in retorts, the radiant heat is at a minimum and the convection heat is at a maximum; whereas, when the same fuel is burned in powdered form, this condition is reversed.

Efficiency of heat transfer through boiler-plates and tubes is materially greater with a radiant heat than with a convection heat, this increase being from 20 to 25 per cent as applying to those portions of the heating surfaces directly affected by the incandescent, non-combustible particles which have passed through the minimum distance.

In a powdered fuel flame, the impalpable ash offers a medium by which the heat of combustion is converted into radiant energy, whereas, in a stoker installation the mass of the combustion gases, although having the necessary temperature, has no medium other than the refractory material in the walls of the furnace, through which to become radiant.

Heat radiates in straight lines, and, from observations taken for furnaces burning powdered coal, intense white flame occurs not only below the first row of tubes but well into the tube bank. From this it is apparent that the radiant effect of the incandescent impalpable ash particles is obtained by fully one-half of the total heat-absorbent surface of the first pass of the boiler, as compared with the radiant heat effect of a much lesser degree which is obtained by only the lower half of the first row of tubes exposed to the fire bed of a stoker installation. Hence it may be concluded that with the results of combustion identical, as regards furnace and exit gas analyses and temperatures, the efficiency of the boiler fired with powdered fuel will be substantially greater, due to the more effective transfer of radiant heat.

Non-Combustible Matter.

Exclusive of moisture, commercial steam coals contain from 5 to 25 per cent of impurities, which means that out of every ton of 2,000 pounds, from 100 to 500 pounds has practically no heat value and is further detrimental.

For all practical purposes, the eight principal impurities that occur in coal may be generalized as follows:

Material	Percentage of total impurities
Silica	25 to 55
Alumina	15 to 35
Iron	10 to 30
Sulphur	trace to 5
Calcium	trace to 5
Potassium	trace to 3
Sodium	trace to 2
Magnesium	trace to 2

These impurities come from three sources—vegetable material; clay, sand, or shale; and extraneous substances—and combine to form a mechanical mixture of silicates, oxides and sulphates. With the exception of sulphur, which is an undesirable element and occurs as iron pyrites or calcium sulphate, all are non-combustible. In general, the silica, alumina, and magnesium content will tend to decrease, while the iron, calcium, potassium, and sodium content will tend to increase the fusibility of the impurities in the coal.

The clinkering and honeycombing of the impurities in coal is one of the most destructive results of combustion where fuel is burned on metal surfaces, and its formation may be either chemical or by adhesion or fusion of particles of ash and combustible into slag. Roughly, each 1 per cent of impurities causes a decrease of from 0.5 to 1 per cent in combustion efficiency, and from 1 to 1.5 per cent in boiler capacity. As practically all the oxygen disappears at a few inches above the grate, this applies particularly where agitation of the fuel bed mechanically mixes the impurities with the combustible and converts the former into the more fusible ferrous silicates, with resultant clinkering and honeycombing.

The tendency of coal to clinker varies almost directly with the content of iron pyrites and inversely with the ash content. When the ash is low in relation to the sulphur content, clinkering is usually extremely bad unless a cooling process, or a counteracting agent such as limestone, is applied to the grates to prevent fusing of the clinker thereto. The pyrites, which is the principal slag-forming material in coal, when reduced to ferrous sulphide passes into a molten state at about 2,150 degrees F. and in combination with the ash forms layers of solid clinker on top of the grates, and stops the passage of the air. The result is that the grates become overheated and cause the clinker to melt and flow through the grate openings. This results not only in clogging and warping the grates, but also in their corrosion and destruction, due to the sulphur combining with the overheated metal.

While the sulphur itself has little to do with the fusibility of the ash, the iron, combined with a part of the sulphur, does. In general, the greater the percentage of iron the more fusible the slag. Furthermore, fused ferrous sulphide fluxes aluminum silicate and also causes clinker.

With the grates clinkered, there is sufficient air for complete combustion, with the result that ferrous oxide is formed and unites with the silica to form honeycomb which becomes very fusible at temperatures over 2,400 degrees F., and will tend to adhere to those portions of the boiler metal and furnace refractories where the temperature is highest.

Thus we find that—due, primarily, to lack of air supply through the metal work on which the fuel bed is placed—we have the cause of both clinker and honeycomb in the production of ferrous sulphide and ferrous oxide, respectively, which, in turn, have a most destructive effect not only on the metal work which is responsible for the restricted air supply, but on the refractory surfaces as well.

When coal is properly prepared and burned in powdered form, the usual difficulties resulting from clinker are eliminated as there are no grates or retorts on which it can accumulate, and it cannot interfere with the air supply requisite for combustion. However, with coal that contains certain intrinsic combinations of ferrous silicates which fuse at relatively low temperatures (2,000 to 2,300 degrees F.) honeycomb formation will result unless the proper fuel, air, and draft regulations obtain to convert the ferrous sulphide into ferric oxide which is the result of complete combustion and requires 50 per cent more oxy-

gen or dry air to produce than ferrous oxide. For this process an oxidizing atmosphere must at all times obtain in the combustion chamber in order to prevent the reduction of ferric sulphide to ferrous sulphide and, as the burning of fuel in suspension is not dependent upon air supply through openings that are liable to become clogged, this can easily be provided.

One important factor that is frequently overlooked with powdered coal installations is the necessity for equipping all furnaces and boilers with effective means for blowing out the fine ash that frequently accumulates on top of the various surfaces. Unless provision is made for this important detail, much otherwise avoidable difficulty is bound to occur with fuel running high in impurities.

Refractories.

Where powdered fuel is used, too much importance cannot be placed on the kind of refractory and the arrangement of the heat-absorbing and radiating walls of furnaces for the purpose of flame and radiant heat propagation, in order to prevent the brick from becoming porous, fluxing away, or scouring out by the corrisive ash or erosive flame.

As to the refractory itself—which must resist the destructive agencies of temperature, slag, load, abrasion, corrosion, and eutectic action—this should preferably be a pressed rather than a hand-molded product, of a dense medium-ground quality that will stand up under a temperature of 3,100 degrees F. It should be properly made to insure against cracking, warping, spalling, crushing, and slag penetration. Such brick when properly laid up with the least possible fire-clay or cement, will, under the conditions obtainable with the better class of powdered fuel equipment, last almost indefinitely with minor periodical renewals.

Another important point, too frequently overlooked, is to equip and operate such furnaces so that the ash and clinker can be cleaned out of the furnace regularly and thoroughly.

Last, but not least, no powdered fuel furnace should be forced to the point where the temperature of combustion cannot all be quickly absorbed or removed from the combustion chamber, as would occur from inadequate or obstructed gas passages to the atmosphere. Much refractory has been ruined by this deficiency and the blame placed on the powdered fuel, which was in no way at fault.

Upkeep.

The cost for the upkeep of a powdered coal installation is one that repeatedly comes up when a comparison is made with stoker firing.

From the Appendix the following items have been taken, and, of course, are included in the figures already given under the cost of handling and preparing coal:

No.	Item	Powdered coal	Stoker
68.	Cost of maintenance of preparation plant, per ton prepared	$0.0400	$0.00
80.	Cost of maintenance of distributing system, per ton handled...	0.0025	0.04
95.	Cost of maintenance of boiler equipment, per ton fired . .	0.0200	0.14
97.	Cost of furnace repairs, per ton fired	0.0400	0.03
	Total cost of upkeep	$0.1025	$0.21

Anyone who has had experience with grate and retort stokers will know of the large number of repair parts that must be carried in stock, of the maintenance charges for renewal of castings and forgings inside of the combustion zone, and of the damage to the refractories in side and bridge walls at the line of the fuel bed, on account of forced blast, ash and clinker —all of which, with the consequent delays in service, are eliminated with powdered coal.

Human Element.

At no time more than during the past three years have we learned the result of individual effort ineffectively, inadequately and unintelligently applied. On the railroads, and in other industries using heat for steam generation and for industrial purposes, the uncontrollable human factor has had its most serious effect on the domestic and commercial fuel supply of the world. This was due largely to the existing methods of firing, combustion, and ash-handling, requiring the use of large labor forces at arduous and non-productive work.

To show what powdered fuel can do to relieve this situation, it is only necessary to cite an instance near your city where the conversion of two continuous billet-heating furnaces from hand-fired to powdered coal, reduced the total number of workmen, per 24 hour period, from 36 to 7; and reduced the fuel consumption from about 450 to 160 pounds of coal per ton of metal heated, with a production of about 150 tons per furnace, per turn. While this may be a striking example, it is indicative of what can be accomplished in labor and fuel saving through the use of automatic mechanical methods for the production of heat from solid fuels.

Cleanliness.

The discomfort and economic loss due to smoke, sparks, and ashes justify due consideration of any method of relief. This is especially true when the improvements will justify their cost by increasing capacity, reducing labor, and minimizing the wastes and nuisances caused by incomplete combustion.

Sufficient evidence of the effectiveness of powdered fuel is now available in various towns and cities where the results from this method, as compared with stoker and hand firing of coal on grates, and with fuel oil, can be demonstrated.

Safety.

During the early use of powdered fuel a number of fires and explosions occurred, due invariably to the use of hazardous methods or to failure to observe the proper instructions.

As has been the case with all mediums for the production or concentration of greater heat and power, there is in the use of powdered fuel a certain element of danger which does not exist with the more ineffective coarse, solid fuels; but, with existing equipment and regulations for the use of powdered fuel, it is a comparatively easy matter to avoid trouble from spontaneous combustion, fires, or explosions.

Editor's Note—Prof. F. J. Denk has arranged to contribute each month an article for the power section of The Blast Furnace and Steel Plant. He will base his articles on practical data obtained from various installations made in boiler houses of steel plants. These articles should prove exceptionally interesting as the power question is a large problem to steel plants just now.

INDUSTRIAL RELATIONS

MODERN SHOP LIGHTING.

O. F. Haas,

Engineering Department, National Lamp Works of General Electric Company.

Reduction of accidents is accomplished by two general methods; first, using mechanical safeguards to the extent that accidents cannot readily happen regardless of what the individual may or may not do; second, improving conditions so as to make them more favorable for prompt response on the part of the physiological senses, making it easier for the individual to know instantly when danger threatens. It is fortunate that one of the most important of our senses, sight, is one whose acuteness we can improve when necessary by an external agency—adequate and proper illumination.

A well known insurance company is responsible for the statement that the number of fatalities resulting from slipping, tripping, and falling exceeds the combined total of fatalities due to anotmobile, street cars, and fires, and also that the yearly casualties in this country traceable to poor lighting exceed the yearly casualties from all causes of the American army during the recent war—over 250,000 a year. In their survey of 91,000 industrial accidents, they find 24 per cent were due in whole or in part to insufficient or faulty lighting.

Lighting for production and lighting for safety are closely related subjects. The man in a poorly lighted shop will automatically move more slowly and more cautiously about his work and the mere fact that he is continually on his guard will undoubtedly show up at end of the day in the amount of work he has accomplished. In Chicago, four tests of the relation of light to production have recently been made that have aroused the greatest interest because of the care in which they were conducted and the conclusiveness of their results. These tests were directed by the lighting committee of the Commonwealth Edison Company and show gains of from 10 to 35 per cent in production simply by raising the standard of illumination.

One who has not given proper thought to the requirements is likely to believe that to obtain good lighting it is only necessary to experiment with lights of various sizes until sufficient light is obtain to permit close discrimination of the objects lighted, but the solution of the lighting problem involves not only the size of the lamp, but the type of reflecting equipment, and location of the light source as well. Good lighting practice calls for the fulfillment of these requirements.

1. Light of suitable quality.
2. Light from the proper direction.
3. Light of the correct intensity.

A discussion of the quality of light leads to a consideration of glare. Glare has been rather loosely defined as "light out of place." It has been more fully defined, however, as any brightness within the line of vision of such character as to cause discomfort, annoyance, interference with vision, or eye fatigue. It is one of the faults most commonly found in all lighting installations, and is one reason why shopmen think they have enough or even too much light when they may actually be suffering from a lack of it. Glare is minimized or eliminated by shading the light source, surrounding it with a diffusing surface, or by reducing the contrast between the light source and its background.

Another form of glare which is often less obvious than that which comes direct to the eye but which is frequently more harmful because of its insidious nature is that which comes to the eye as a reflection of the light source from some polished surface. This form of glare, known as specular reflection is frequently encountered where the work is with glossy paper, polished metal or furniture, or other shiny surfaces, and is particularly harmful because of the fact that the eye is often held to such surfaces for long periods of time, and while the glare may not be sufficiently annoying to cause immediate discomfort it may, nevetheless, in time produce eye fatigue and possibly permanent injury. Specular reflection can be minimized or eliminated by reducing the brightness of the light source, or by locating the light source in such a position with respect to the work that specularly reflected light will be thrown away from rather than toward the eyes of the operator.

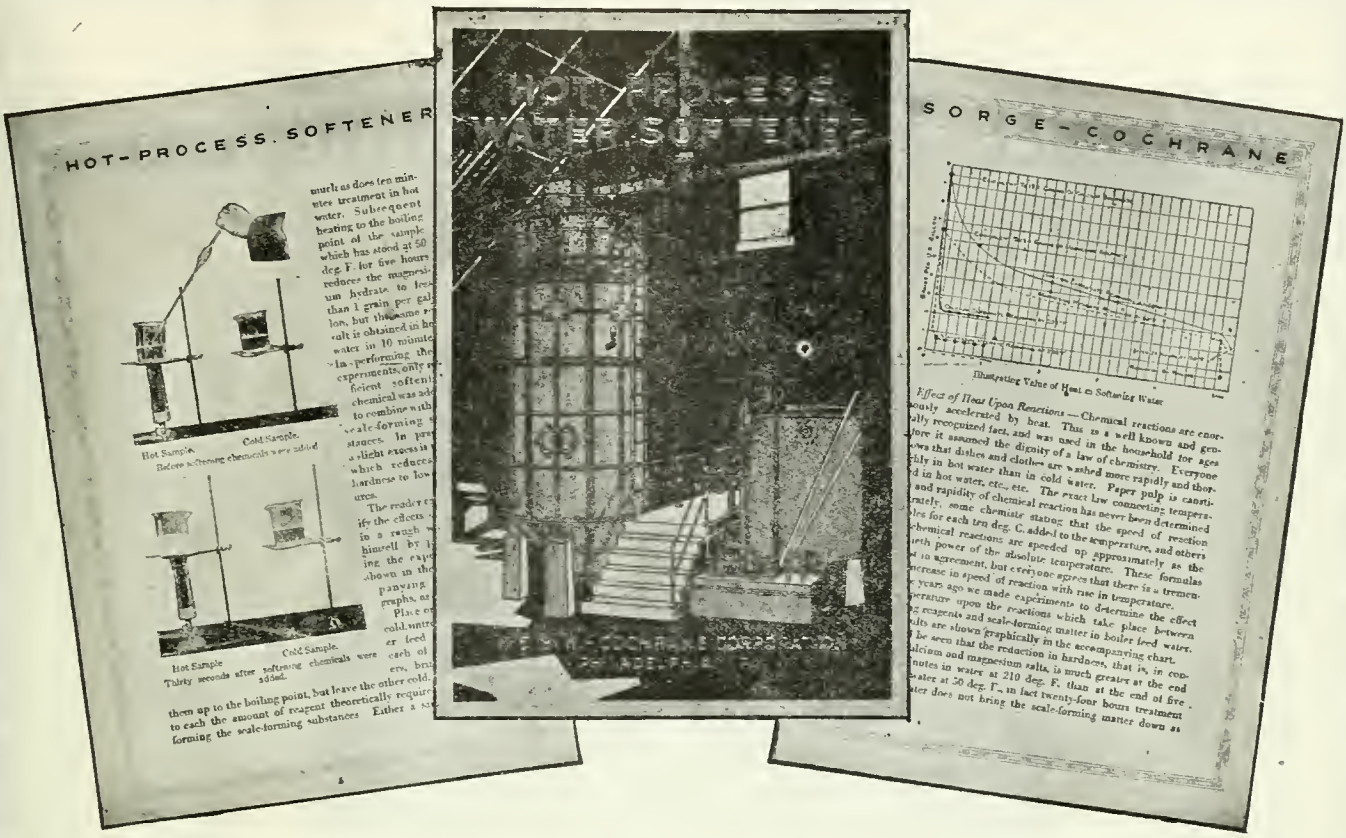
In regard to the color of light, except for special cases in which colors are to be determined in their true daylight values, artificial light, within the range in which daylight varies in quality, will be found generally satisfactory.

The second requisite for good lighting is light from the proper direction, and this requisite naturally entails a consideration of shadows. Shadows may be troublesome if they are so dark that it becomes difficult to distinguish between shadows and objects, or if the illumination in the shadows is insufficient for good vision. A maximum degree of shadows results in the case of direct lighting system using clear lamps in open reflectors of small area; a minimum in that of totally indirect lighting. In industrial work, where it is generally necessary to view objects in their three dimensions, shadows are an aid to vision in that the surfaces can be more easily distinguished than when they are all lighted to the same intensity. With few exceptions, soft, luminous, shadows only are desirable in interior lighting, while those having sharp edges or a series of sharp edges are objectionable. With general (overhead) lighting shadows from the work or fixed objects can be reduced by placing the units high and close together.

The third requisite for good lighting is light of the correct intensity.

In the matter of light quantity, a wide divergence of opinion exists as to what constitutes proper lighting intensities for specific applications. At very low intensities the eye does not receive sufficient light to enable it to distinguish color or detail, and at very high values a blinding effect also obliterating detail is experienced. The human eye will accommodate itself to a wide range of illumination, from a fraction of a foot-candle to the 5000 foot-candles or more corresponding to the illumination outdoors on a sunny day. Consideration of economy usually limits the intensities employed in artificial lighting, however, to the lower values of this range. Tables have been worked out and published showing the intensities considered sufficient for various industries, and the different operations carried on in these industries. These values are constantly changing as experience proves a change desirable.

Continued on Page 534



If You Own Or Manage Steam Boilers You Should Read This Book

It is a treatise on the modern science of softening water for feeding boilers.

It explains the effects of heat upon chemical reactions, showing that calcium carbonate and magnesium hydrate are reduced more in ten minutes in hot water than after five hours in water at 60° F.

It explains why precipitates settle more rapidly in hot water than in cold water, in accordance with the fact that the viscosity of water is six times greater at 32° F. than at 212° F.

Analyses of water before and after treatment in Sorge-Cochrane Hot Process Softeners are cited to demonstrate the superior results obtained in the practical application of these principles. In most cases the total encrusting solids are reduced to less than two grains per gallon.

The problem of feeding chemicals into a Hot Process Softener, which should be operated under back pressure, is analyzed and a practical and efficient proportioner which feeds chemical solution in proportion to the raw water with an accuracy within one-half of 1% is described.

The adaptability of the hot process softener to various steam plant conditions and the advantages gained by the use of soft water in boilers in the way of protection against overheating of the metal, saving in fuel and saving in cost of cleaning boilers are discussed.

The various harmful substances found dissolved in boiler feed boilers are described and the chemistry of their removal, together with the cost of various reagents required are given.

If you are interested in these and allied subjects, ask for publication No. 933-F.

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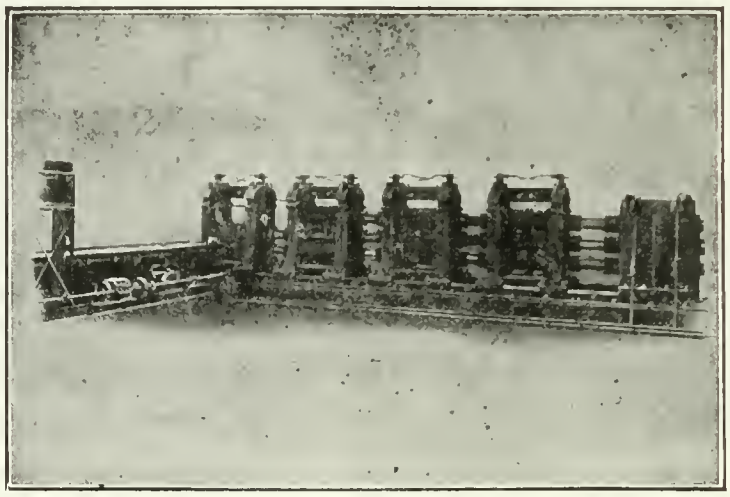

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FOREIGN RELATIONS

FRENCH AUTOMOBILE MANUFACTURERS TO INVESTIGATE AMERICAN MARKET.

A report from Paris says that French firms are considering the United States as a market for their cars. Pierre Bassett, representative of the Syndicat Francais des Constructeurs d'Automobiles, will leave France shortly to investigate conditions here and on the basis of his report will map out their sales campaign.

Due to the French exchange situation and the low cost of freight space on ships returning to the United States, Mr. Bassett expects to place French trucks on sale here at prices which will compare favorably with local prices. Moreover, many of the large French concerns have developed considerable technique in fast construction. Their appeal will be directed toward customers in this country who are willing to pay the higher price for "something different."

PEAK IN SHEFFIELD IRON PRICES REACHED.

Consul William J. Grace, Sheffield, England, June 30, 1920.

The conditions in the steel trade at Sheffield are not so favorable as they were some months ago. Offers in England and on the Continent of large tonnage of semi-steel bars and plates from the United States at prices below the British quotations has had a depressing effect. It is reported that a good quantity of orders has been given to United States manufacturers. This competition and some cancellations of foreign orders have weakened somewhat the position of British makers. It is said the premiums on basis prices asked here have been modified. The tendency of costs is, however, in an upward direction. In finished steel there is a decrease in inquiries and new business, and while makers have sufficient orders to keep them busy for the remainder of this year the prospects for the new year are not bright.

There is a great scarcity of all descriptions of pig iron. West coast hematite costs about £16 ($77.86 at normal exchange) per ton delivered to local stations. Foundry iron is about £13 10s. ($65.70) per ton and in extreme cases £14 (68.13). Makers of finished iron can dispose of their output as fast as they can make deliveries. It is reported that several iron and steel contracts have been accepted without the clause which protects the seller against increased costs. This would indicate that the apex of prices has been reached.

PEKING TO HAVE BLAST FURNACE.

Preliminary work has been begun, and material is now on the way from the United States for a 250-ton capacity blast furnace which, it is stated, will form the first unit of a modern steel mill that will make Peking the Pittsburgh of China. A group of Chinese officials and substantial business men, headed by General W. S. Y. Tinge, managing director of the Peking-Hankow railway, has been formed to carry through the undertaking. The site chosen is about 10 miles west of Peking on the Yangting river, where the consulting engineer, Lawrence J. O'Loughlin, of the New York firm of C. P. Perin and S. M. Marshall, found ample water supply just about midway between the points north and south of the railway line from which the furnace will be supplied with its coke and iron.

Mr. O'Loughlin left recently for New York, having completed his part of the work. American engineers will superintend the construction and direct the plant after it goes into blast. The blowing-engines, boilers, pumps, etc., were ordered in the United States some time ago to plans and specifications prepared by the well-known New York engineer. The estimate for the first unit is understood to be slightly more than $3,000. It is expected that General Tinge will take personal charge of this important new Chinese industry, resigning his directorship of the Kin-Han railway so as to be free to give all his attention to the future steel mill.

In conversation with a representative of the Far Eastern Review, Mr. O'Loughlin spoke very pleasantly of his experiences at Peking. He has great faith in the possibilities of Peking as a Chinese steel center and he praises the practical sense of the Chinese business man.—Far Eastern Review.

SURVEY OF IRON AND STEEL TRADE OF DUTCH EAST INDIES.

Trade Commissioner John A. Fowler, Batavia, Java.

A survey of the iron and steel trade of the Dutch East Indies shows that trade conditions in that colony were normal in 1913, prices were low, and much new construction was under way. In 1917 the prices, according to the American market, had touched a point 260 per cent above the high point of 1913. After the beginning of the war construction in Java dropped to the minimum of necessity and plans for development have since been held in abeyance. In 1918 there was an increase in the imports as shown by the quantities recorded. In that year the United States supplied a large percentage of the total and Australia appeared for the first time as an important factor in this trade.

Rails and Fittings.

The imports of rails, fishplates, and plates for cars into the Dutch East Indies for the years 1913, 1917, and 1918 are shown below. Values, in guilders (1 guilder = $0.402), are given for 1913, as no quantities were stated in the official customs returns for that year, and accurate estimates cannot be made. The figures of value serve only to show the percentage of origin of the trade by countries. The Netherlands is credited with 85 per cent of the trade, but it is safe to say that a very large proportion of these imports originated in Germany. Quantities are given in metric tons (1 metric ton = 2,204.6 pounds) for 1917 and 1918:

Countries	1913 Guilders	1917 Metric tons	1918 Metric tons
United States	.....	6,036	7,828
Netherlands	5,612,587	1,017	58
Great Britain	107,961	19	3
Germany	131,403	....	....
Belgium	679,816	....	....
Australia	.....	....	1,214
Singapore	11,349	134	6
Japan	.....	....	165
All other countries	1,095	1	....
Total	6,544,211	7,207	9,274

PRODUCTION TOPICS

INGOT PRODUCTION FALLS

The steel ingot production in the United States in July, as reported by the American Iron and Steel Institute, was 2,802,818 gross tons for 30 companies which made about 85 per cent of the steel ingot output for 1919. This total is considerably less than that for the same companies in June, the figures for that month being 2,980,690 tons. The falling off was relatively greater than that in pig iron production. If the remaining 15 per cent produced at a rate corresponding to that of the 85 per cent, the total output of the country in July was 3,297,433 tons, or 126,824 tons a day, counting 26 operating days. On a like basis the total output of the country in June was 3,549,440 tons, or 136,478 tons per day, nearly 10,000 tons per day more than in July.

The figures below from the monthly reports of the American Iron and Steel Institute show the distribution as between Bessemer and open hearth steel ingots. Statistics were not gathered in September, the first month of the steel strike, or in the three months following. The Iron and Steel Institute's statistics of the past year are referred to in its reports as being from companies producing 84.03 per cent of the total output in 1918. The July statistics just brought out change the basis of comparison, the 30 companies making reports being referred to as producers of "about 85 per cent of the steel ingot production in 1919."

Monthly Production of Steel Ingots by 30 Companies Which Produced About 85 Per Cent of Total in 1919—Gross Tons.

	Open hearth	Bessemer	All other	Total
January, 1919	2,351,153	749,346	7,279	3,107,778
February	2,043,635	655,206	5,842	2,704,683
March	2,100,528	555,332	6,405	2,662,265
April	1,732,447	500,770	6,494	2,239,711
May	1,506,015	414,392	8,617	1,929,024
June	1,692,257	521,634	5,328	2,219,219
July	1,875,630	625,246	7,300	2,508,176
August	1,988,651	748,212	9,218	2,746,081
January, 1920	2,242,758	714,657	10,687	2,968,102
February	2,152,106	700,151	12,867	2,865,124
March	2,487,245	795,164	16,640	3,299,049
April	2,056,336	568,952	13,017	2,638,305
May	2,251,544	615,932	15,688	2,883,164
June	2,287,273	675,954	17,463	2,980,690
July	2,135,633	653,888	13,297	2,802,818

The production of steel ingots in the first half of 1920 was at the rate of about 42,000,000 tons per year. The July rate represents but little over 39,000,000 tons per year.

CURRENT PERIODICITY IN THE UNITED STATES.

An analysis of 60 of the large electrical power systems in the United States shows that 49 generate 60-cycle, 6 generate 25-cycle, 4 generate 60 and 25-cycle, and 1 generates 50-cycle alternating current. There are approximately 4,750,000 kilovolt-amperes of 60 cycle, 1,250,000 kilovolt-amperes of 25-cycle, and 160,000 kilovolt-amperes of 50-cycle generating capacity installed on these systems. If we are going to standardize on a frequency, says Power, New York, why not take 60-cycles, since this system predominates to such a large degree, and is probably better suited to general power requirements than any other?

MODERN SHOP LIGHTING.

Continued from page 532.

Until very recently it was practically impossible for a shop manager or superintendent to determine the amount of illumination he had in his factory. The foot-candle meter which has recently been put on the market is an inexpensive, reliable, and simple instrument which may be used for checking up the intensities obtaining.

The intensities found may then be compared with published data showing the desirable intensity for the specific class of work.

There has been in the past, and there is even at present a various assortment of reflectors employed in industrial lighting. However, porcelain enameled steel reflectors, because of their mechanical strength, the permanence of their reflecting surface even under unfavorable atmospheric conditions, their moderate cost, and the ease with which they can be kept clean, have become the most generally employed of all industrial reflectors. Their design has recently been highly developed.

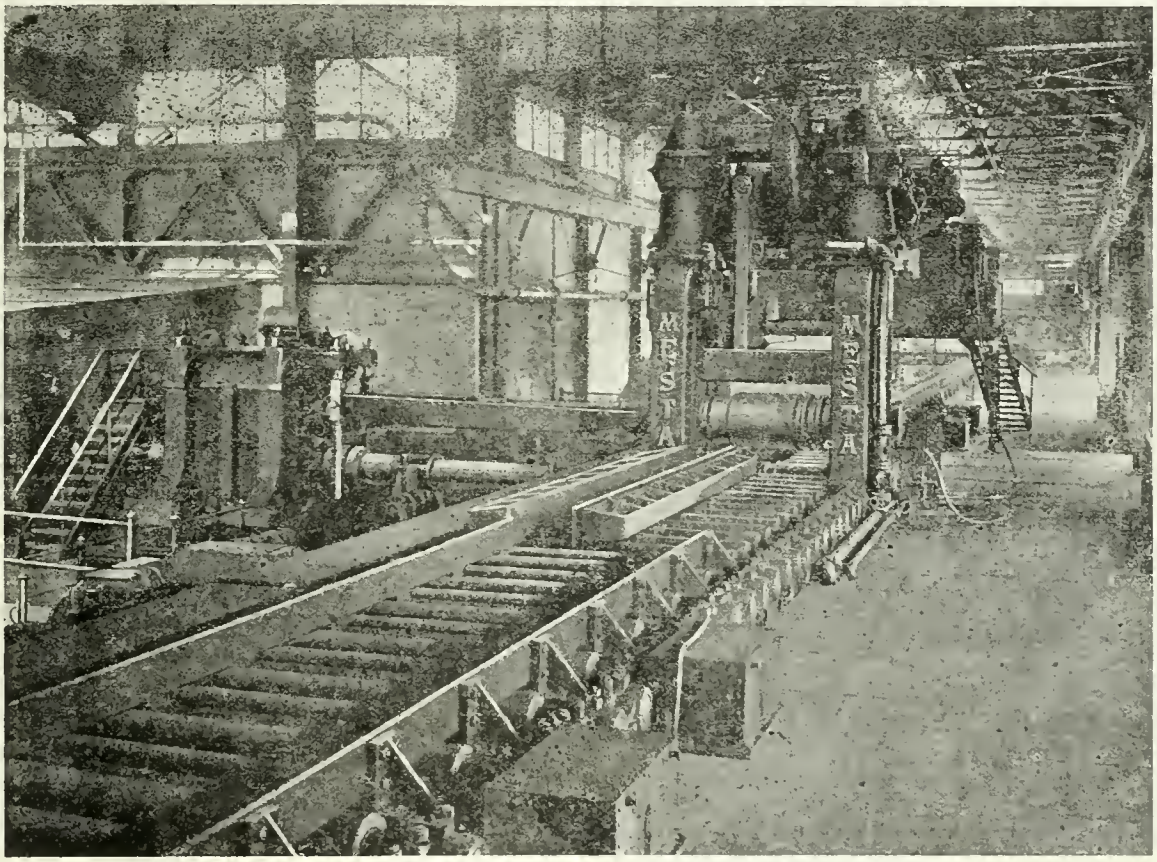
The porcelain enameled steel reflectors in common use in the past and today may be divided into three general classes. The flat reflector is, in general, inefficient and glaring, its use for any interior lighting should be most emphatically discouraged.

The bowl reflector protects the eye in part from the direct glare of the filament, but, for many purposes it is not the best unit obtainable as regards efficiency, reflected glare, shadows, and the illumination of vertical surfaces.

The dome reflector, which falls in a class between the flat and bowl type, is, in general, superior to either, and it is by far the most widely used reflector in industrial lighting today. When equipped with a lamp, the bowl of which has been made diffusing by frosting or some other method, this reflector combines reasonable eye protection with a large source of light, soft shadows, moderate specular reflection, and good vertical illumination.

However, the usual angle of cut-off for dome reflectors is 10 to 13 degrees below the horizontal and investigation has shown that the results can be markedly improved by making the reflector deeper so as to have the angle of cut-off 15 to 20 degrees below the horizontal. The reflector and lamp manufacturers recognizing the shortcomings of existing industrial reflectors have designed a standard line which best serves the industrial lighting field. The purpose of this standardization is to contribute toward better industrial lighting by establishing high standards of quality and performance for metal reflectors and to assist in simplifying the selection of proper reflecting equipment. This new design virtually combines the advantages of the older dome and bowl types. The new reflector is known as the RLM (Reflector and Lamp Manufacturers') Standard Dome. The specifications covering this design provide: (a) A durable and highly efficient reflecting surface. (b) A contour of reflector which will insure an effective lighting distribution. (c) A diameter and depth for each size which will produce adequate diffusion of light, and a sufficient screening of the source to minimize glare.

MESTA BLOOMING-MILLS



40" Mesta Blooming Mill Installation

Designed and Built for Maximum Production

A DELAY in the operation of the Blooming Mill not only means a decrease in production and increase in cost of material being rolled; but very often causes delays and added expense in other departments that are dependent upon the Blooming Mill for material.

Mesta Patented Universal Spindles and Couplings, with Spindle Shifting Device which permit quick roll change; quick acting Screw Down; Forged Steel Spindles and many other distinctive features with respect to design and material used, **insure continuous operation to the greatest possible extent and practically eliminate the possibility of any serious delay.**

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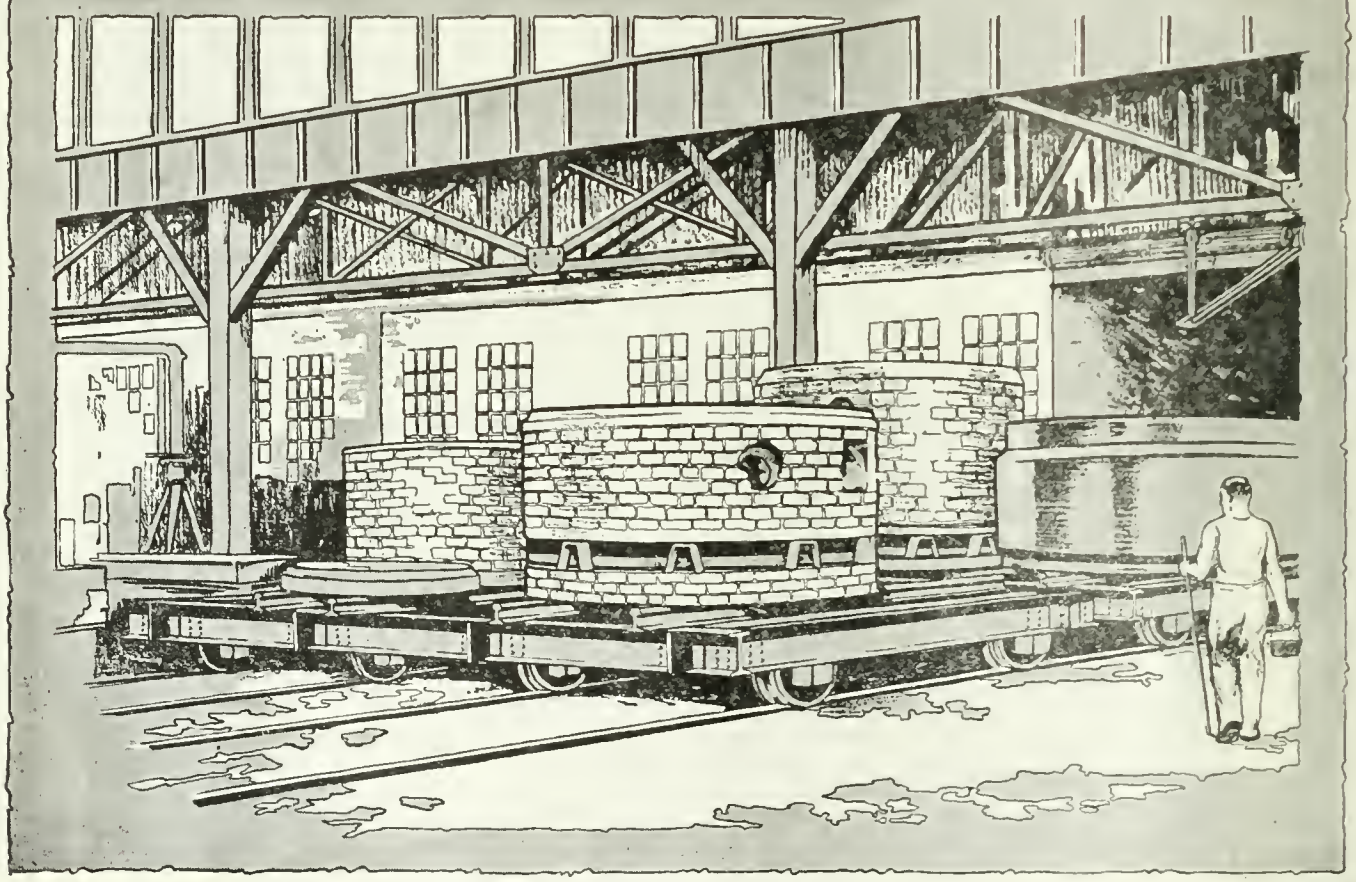


EASTON CARS

Easton service puts thirty years' experience in industrial railway problems at your disposal. Ask for recommendations for your plant.

If the loads in your plant are heavy or hot or hard to move by hand or crane, a well laid out industrial railway will make every part of a big establishment "convenient"—save men and time—and prove as big a factor in quantity production as any other item of equipment.

Core Oven Cars, Billet Cars, Charging Box Cars, Pig Iron Cars of every description—whatever the car an iron foundry, steel plant, or rolling mill has found most suited to efficient operation, we make in any capacity and gauge.

And into every car goes not alone the experience of thirty years in producing the right car for particular purposes, but also the high quality of material, the careful workmanship, the satisfactory service for which the name of Easton has always been sufficient guarantee.

Take advantage of Easton service—which advises freely, and can deliver promptly every item of an industrial railway, from specially designed single cars to miles of track and complete trains.

EASTON CAR & CONS'T'N CO.

2075-E

GENERAL OFFICES 44 CHURCH STREET, NEW YORK WORKS: EASTON, PA.

Boston Chicago Detroit Philadelphia Pittsburgh

WITH THE EQUIPMENT MANUFACTURERS

MECHANICAL RUBBER GOODS FOR THE BLAST FURNACE.

There are not a great many uses for belting, hose or packing in connection with the blast furnace. Where these are required, they should be furnished of such material and so constructed that they will give the longest possible life at 100 per cent efficiency. For instance, hot stove door packing that has to be replaced frequently is an expensive material to use.

The United States Rubber Company, mechanical goods division, have perfected a hot stove door packing that has proven most economical and efficient. This is, also, true of their hot blast valve packing and Vanda sheet has also proven very efficient for Peek-hole Gaskets.

As to the water hose, used around a blast furnace, some concerns feel that an ordinary piece of hose, frequently replaced, is a better proposition than a high-grade hose, properly constructed and covered to give long life and the United States Rubber Company advise that they believe the higher grade hose provides a factor of safety and at the same time results in more economical operation.

THE MONO SYSTEM.

The unique characteristic of the Mono system lies in the commercially new feature (at least in America of getting a continuous record of combustible gases (CO-CH_4) as well as CO_2 leaving a furnace with other products of combustion, where CO_2 has heretofore been the only one recorded for the purpose of controlling boiler and other furnaces.

Many systems involving tables and curves have been developed whereby it was thought to make possible the attainment of maximum efficiency in combustion on the basis of a CO_2 record only.

PUMPS ARE STARTED.

By the use of electrically operated valves, the pumps supplying water for domestic and fire purposes at the U. S Nitrates Plant No. 2, Muscle Shoals, Ala., may all be connected in tandem for meeting emergencies by the throw of single switch without any other operation necessary. The closing of the switch causes the Dean control units, with which each valve is equipped, to change the valves so the domestic supply pumps are put in tandem with the fire pumps.

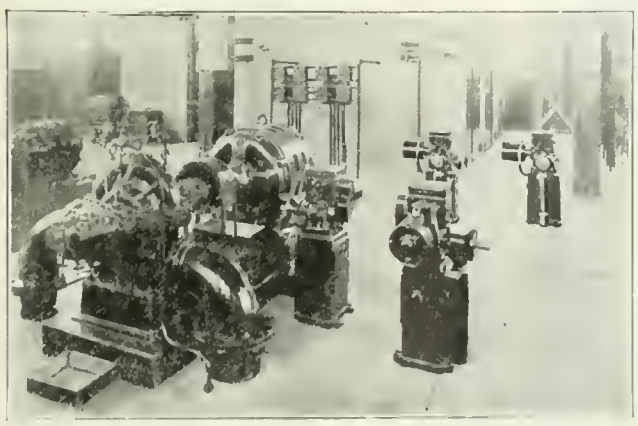


Fig. 1—Dean valve control floor stands and control stations in the reservoir pump house, U. S. Nitrates Plant No. 2.

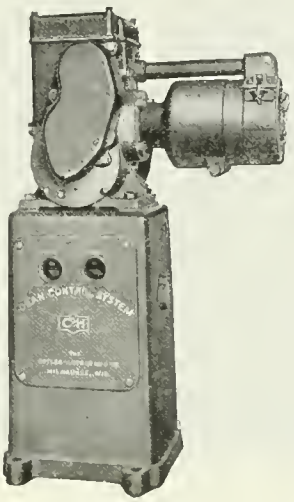


Fig. 2—Floor stand with control motor and mechanism mounted on top. Pilot lamps indicate whether the valve is open or closed.

Another advantage is obtained by connecting the motors of the Dean control units, which operate the discharge valves of the fire pumps, to the electric pump control system, so that as the pumps start up the discharge valves are automatically opened.

The pumping equipment consists of four 18-inch high speed centrifugal pumps and six other pumps ranging in size from 5 to 8 inches. The pumps are of the single stage type capable of delivering against a head of 150 feet, and are driven by ac motors. On the intake and discharge of each of the larger pumps are fitted Rensselaer inside screw bronze mounted iron body gate valves with extension stems projecting up through floor stands in the pump room, as shown in the illustration. The valves vary in size from 12 to 24 inches in diameter, and are controlled by individual control stations mounted on the wall. These control stations provide independent means for controlling each of the valves. Mounted on the floor stands are standard E-1, 110-volt direct current Dean control units, which open and close the valves in conjunction with the starting and stopping of the pumps, and which are provided for hand operation of the valves in case of an emergency.

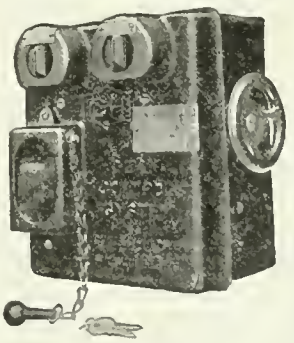
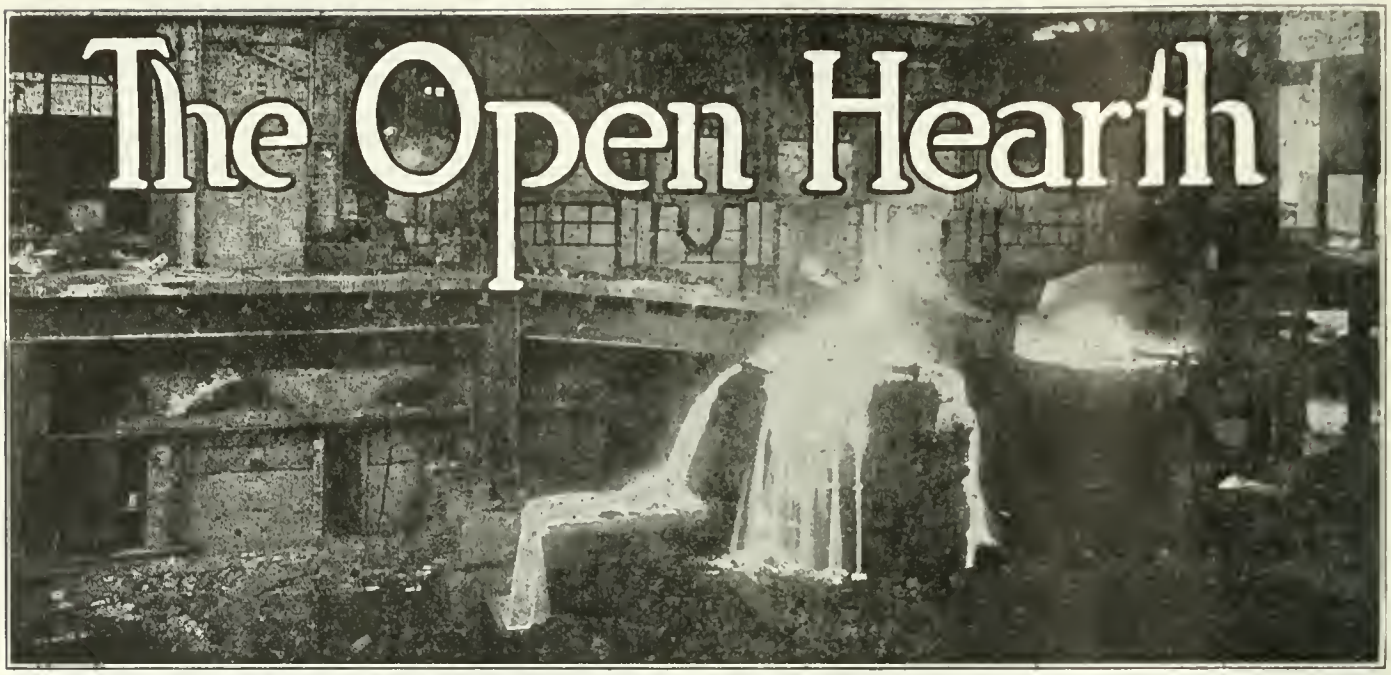


Fig. 3—The control station is a fully enclosed reversing switch, provided with a lock. In emergency cases, it can be operated by breaking the glass cover and unlatching the switch.

NEW CO$_2$ EQUIPMENT.

Uehling Instrument Company, 71 Broadway, New York, has just issued bulletin No. 111, describing Style U Uehling CO_2 equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator.



H. A. ANDRESEN RETURNS FROM WORLD TOUR.

Herbert A. Andresen, president of the National Iron and Steel Publishing Company, which publishes THE BLAST FURNACE AND STEEL PLANT, THE AMERICAN DROP FORGER and THE COAL INDUSTRY, accompanied by his wife, has returned from a world tour, with valuable engineering and commercial information concerning every important country in the world.

H. A. ANDRESEN.

Imbued with the idea of creating for his engineering publications an international contact and with a desire to assist American interests in foreign lands, Mr. Andresen started on his tour immediately after the signing of the armistice.

After a thorough tour of the United States he embarked upon his mission; sailing westward, he visited the Hawaiian Islands, Japan, China, Philippine Islands, Australia, New Zealand, Straits Settlement, Malay States, India, Arabia, Egypt, Turkey, Greece, Serbia, Italy, France, Germany, Holland, Belgium and England.

Mr. Andresen has personally appointed capable and practical correspondents in each country visited and he believes that the greatest opportunity ever presented to America is in cultivating the prolific markets of the Orient.

M. A. Green, formerly superintendent of agencies and branches of the Crucible Steel Company, has been made secretary and general manager of the C. D. Pruden Corporation with headquarters at Baltimore.

V V

J. Lester Mauthe has resigned his position as assistant superintendent of blast furnaces at Gary, Ill., to become superintendent of blast furnaces at the Lorain plant of the National Tube Company.

V V

J. A. Gibboney has been promoted to assistant millwright general at the Youngstown plant of the Youngstown Sheet & Tube Co.

V V

J. B. Faulds has been appointed general master mechanic of the Brier Hill Steel Company at Youngstown, O. Mr. Faulds was formerly assistant millwright general for the Youngstown Sheet & Tube Co.

V V

John Eaton has been promoted to the position of effeiency engineer at the Brier Hill Steel Company, Youngstown, O.

V V

Joe Bracken, formerly mill recorder on No. 1 blooming mill, and James Murphy, shipper at the Morgan billet mill, have been appointed foremen on No. 3 blooming mill at Jones & Laughlin's South Side plant.

V V

Edward Harmon has been appointed to succeed F. C. Laughran as superintendent of the bloom yard at Jones & Laughlin's South Side plant.

V V

C. K. Southard has been promoted to the position of chief engineer of the C. D. Pruden Corporation, Baltimore, a subsidiary of the Blaw-Knox Co.

V V

Evans Jones has beeome manager of the Harrisburg plant of the Lalance & Grosjean Manufacturing Co. Mr. Jones was formerly superintendent of the sheet and jobbing mills of the Bethlehem Steel Company at Sparrows Point, Maryland.

V V

Fred C. Moses, formerly designing engineer of the Bethlehem Steel Company, Bethlehem, Pa., has been appointed assistant mechanical engineer for the Aluminum Company of America, Pittsburgh, Pa.

V V

J. E. Cook, formerly superintendent of the finishing mills of the Eastern Rolling Mill Company, Baltimore, has been made assistant to the general superintendent, C. A. Pennock.

Avoid Winter Tieups and Embargoes by Getting Your

ASHLAND FIRE BRICK

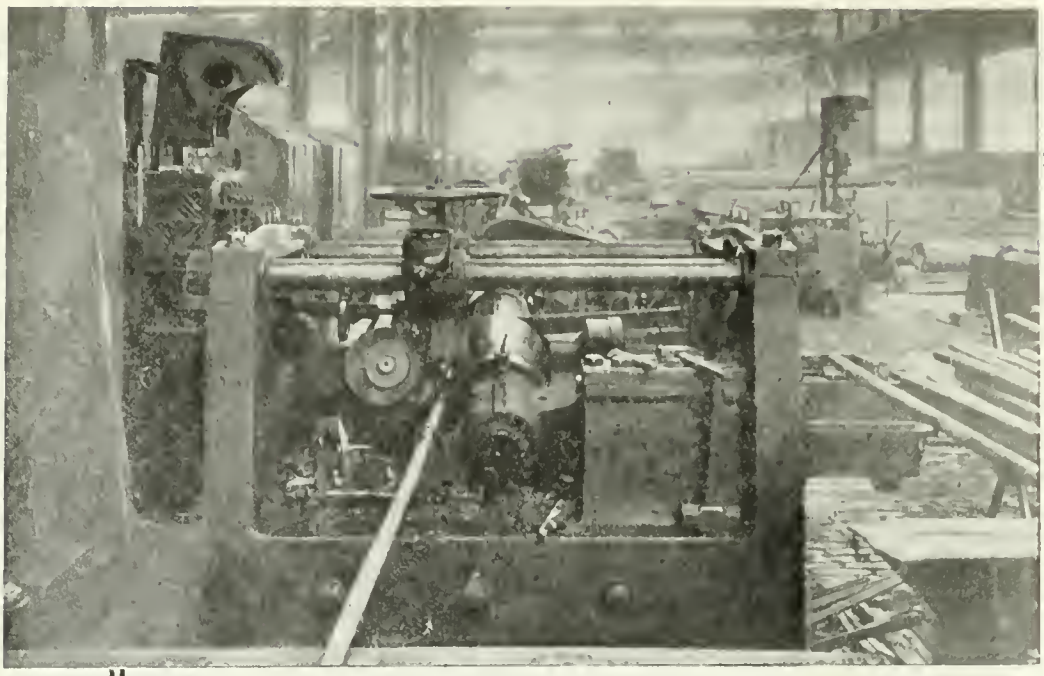
Don't wait until the snow flies before putting through that order for your Ashland Fire Brick. Orders placed now will allow us time to make deliveries on brick that will be needed later on, thus eliminating a possible delay when it comes time to line your furnaces. Delay now may require you to resort to a "substitute" later, thereby losing the opportunity of having your furnaces lined with the Ashland Fire Brick made from Carter County (Kentucky) Clays, the Country's best clay deposits and moulded into Fire Brick by an experienced organization that knows the Fire Brick game from A to Z.

Ashland Fire Brick Co.

Ashland, Ky.

"Line with the Ashland Line"

Co-operate:—Refer to The Blast Furnace and Steel Plant



The above illustration shows one of the Medart Straighteners at the plant of the Bethlehem Steel Company, Bethlehem, Pa. These machines are operated by ordinary labor and are cutting straightening cost by straightening, polishing, and cold rolling in one operation.

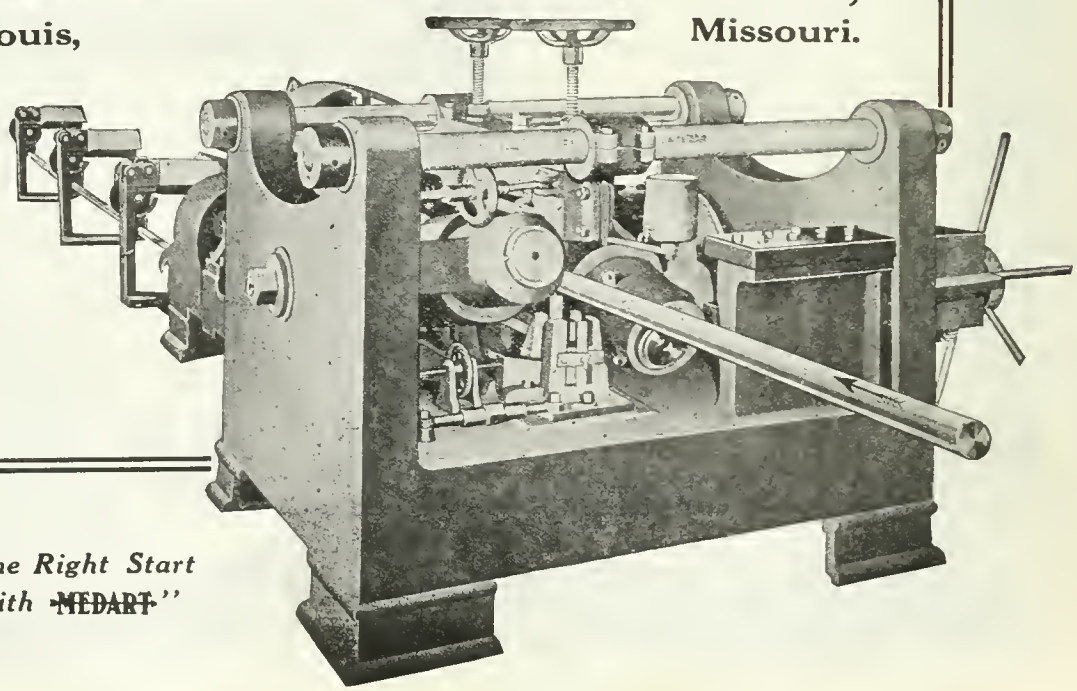
MEDART Continuous Automatic Bar Straighteners

Operate continuously and will straighten any length bar diameter 1/16" to 6 from 40 to 80 feet per minute. All that is necessry in the way of finishing bars after turning either in the Medart Turning Machine, lathes or any other turning device, is to pass them through the Medart Straightener. This removes all tool-marks, restraightens, and puts on a very high polish. There is no chucking device. Consequently, the "Medart" straightens the bar to the extreme end. Very heavy and rigid. "Fool-proof."

Your request will bring full information to you.

MEDART PATENT PULLEY CO.,

St. Louis, Missouri.



"To get the Right Start —Equip with MEDART"

D. H. McDougall, president of the Novia Scotia Steel & Coal Co., has been elected a director of the Dominion Steel Corporation.

V V

Frank Purnell has been elected vice president of the Consolidated Steel Corporation, 165 Broadway, New York, to succeed H. H. Barbour, who recently resigned to become vice president of the Lackawanna Steel Company. The change was effective August 1. Mr. Purnell, who long has been well known in the steel industry, served directly under Mr. Barbour practically since the formation of the Consolidated Company. A. Van Winkle was elected secretary of the Consolidated Company, effective August 1, and C. L. Hayes was appointed comptroller and assistant secretary.

Mr. Purnell formerly was employed by the Youngstown Sheet & Tube Co., in its Youngstown offices and when the war broke out he went to Washington with the organization of the War Industries Board, being assistant to J. Leonard Replogle, then director of steel supply. He made a fine record, and after the armistice and the dissolution of the board, he went to the New York offices of the Consolidated Company.

V V

F. P. Moran, who has been superintendent of the Coke plant for Brier Hill Steel Company has been made superintendent of the Western Reserve Works of the same company at Warren, O. Mr. Moran will be succeeded at the coke plant by G. T. Williams, formerly assistant superintendent.

V V

Nelson A. Zeiger has joined the engineering department, Buckeye Steel Casting Company, Columbus, having resigned his position with the Eastman Kodak Company, Rochester.

V V

The Carpenter Steel Company, Reading, Pa., announces the election of Fred A. Bigelow as president, succeeding W. B. Kunhardt, who becomes chairman of the board of directors. He was graduated from Worchester Polytechnic Institute in 1891 and was employed by Spaulding & Jennings Co. (later part of the Crucible Steel Company of America) as chemist in 1892. In 1900 he was sent to Providence, R. I., as manager of the Providence warehouse and territory for the Crucible Steel Company of America. He entered the employ of the Carpenter Steel Company in 1904 as New England salesman and in 1910 transferred to the Cleveland warehouse as Western sales manager. In May, 1915, he was transferred to Reading as general sales manager.

J. Leonard Replogle, president Vanadium Corportion of America sailed for Europe on the Mauretania, July 1, for a 10 weeks stay in the interest of the Replogle Steel Company and the Vanadium Company. The purpose of his trip is to figure on some large contracts.

V V

J. W. McQueen, president Sloss-Sheffield Steel & Iron Co., Birmingham, Ala., who has been on an extended recreation trip in the Northwest, returned July 1.

V V

W. C. Hamilton, formerly works manager of the American Steel Foundries, Granite City, Ill., has been appointed works manager of the Duquesne Steel Foundry Company, Coraopolis, Pa.

V V

Wilford L. Stork resigned recently as foundry superintendent of the Detroit Valve & Fittings Co., Wyandotte, Mich. He now is works manager of McCord & Co., West Pullman, Ill., foundry operators.

V V

W. Woodward Williams has resigned as vice president and general manager of the Reading Iron Company, Reading, Pa., and will become assistant to the president of the Pittsburgh Gauge & Supply Co., Pittsburgh, September 1. Mr. Williams is understood to have acquired a substantial stock interest in the Pittsburgh Gauge & Supply Co., a large jobber of mill, mine and railroad supplies, as well as manufacturer of washing machines, ironing machines and vacum cleaners. Mr. Williams is widely known among manufacturers of iron and steel products throughout the country and also among users of iron, steel and tubular products because of his extended experience in these fields.

Mr. Williams was born in Cleveland, October 21, 1882, and after being graduated from Harvard University in the class of 1905, he spent six years in the mills of the Carnegie Steel Company, at Pittsburgh and Duquesne, Pa., and Youngstown, O. His first selling experience was with the Bourne-Fuller Company, Cleveland, and later he was appointed manager of that company's Pittsburgh office. In January, 1914, he became general manager of sales of the A. M. Byers Company, Pittsburgh, and subsequently was made its general manager. On August 1, 1919, he became general manager of the Reading Iron Company, and afterward was elected vice president of the Reading company in charge of sales and operations.

NEWS OF THE PLANTS

The Electric Alloy Steel Company, Youngstown, O., has perfected financing plans covering an appropriation for proposed expansion. Extensive improvements and extensions will be made at the works at Charleroi, Pa., recently acquired from the Universal Steel Company, and a large new plant is projected on a 150-acre site at Niles, O. At the Charleroi works it is planned to install two new steel making furnaces, electric-operated, a new crucible furnace, and the construction of a new yard to facilitate the handling of materials. The capacity of this plant will be increased from about 10,000 to 25,000 tons per annum. The present equipment consists of two crucible steel furnaces and one electric furnace, rolling mills, 10-inch and 16-inch, forge shop with complete hammer department, complete cold processing plant, with lathes, straightening machines, annealing and heating equipment, etc., as well as boiler and power plant for general works service. The furnace equipment will be started up at once at this plant, with principal output devoted to ball and roller bearings, steel rods and similar high-grade products. Preliminary plans are being perfected for the new steel works at Niles, and a large investment will be made there. L. J. Campbell is president, and W. D. Myers, secretary and treasurer.

The Phoenix Iron Works Company, Meadville, Pa., has arranged for a stock issue of $1,500,000, and will use a large part of the proceeds for extensions and improvements at its plant for increased production. Details of the proposed work are now being arranged, and considerable new equipment will be installed to give employment to a number of new operatives. The company specializes in the manufacture of gray iron castings, machinery for sugar mills, steel works equipment, tanks, locomotive cylinders and kindred products.

The Beaumont Iron Works Company, Beaumont, Tex., is planning for the early erection of a number of additions to its plant for increased capacity. The extensions will include a new main one-story building, 40x170 feet, to be equipped as a foundry and for general iron working, with three-story building adjoining, to be utilized for similar service, including a machine shop department, and other buildings for auxiliary works service. The installation will comprise new machinery of various kinds, including electric traveling cranes, machine tools, iron-working equipment, foundry apparatus, etc. The entire project is estimated to cost about $200,000. The company recently increased its capital from $225,000 to $700,000 for expansion. L. J. Black is president; Robert Cummings, Houston, Tex., is engineer for the new structures.

The Stanley Steel Welded Wheel Corporation, Boston, Mass., has acquired a large tract of land at North Tonawanda, N. Y., totaling about 30 acres, and has preliminary plans under way for the erection of a new plant. The first buildings will cost about $75,000. The equipment installation will include electric cranes, presses and a full complement of iron and steel working machinery. James T. MacMurray is president, and Samuel E. Guild, Jr., secretary and treasurer.

The Hamilton Furnace Company, Hamilton, O., operating the Miami furnace at this point, is planning for the erection of a new machine and repair shop, and will build this structure of a size to accommodate equipment in the present building and new machinery for increased output. The present shop will be used for a welfare building for employes on the completion of the new building. A new warehouse has recently been completed at the plant.

The Frasse Steel Company, 41 Canal street, New York, has completed plans for the erection of an addition to its plant at Hartford, Conn., and will inaugurate immediate construction. The structure will be one-story, brick and steel, 35x100 feet, and will form an addition to one of the existing buildings at the plant. The company specializes in the manufacture of steel tubing, tools, and other steel products.

The Ford steel plant, near Detroit, Mich., operated by Henry Ford, head of the Ford Motor Company, has inaugurated active production, and while the project is far from completion, the initial units will be placed in service as soon as ready. The works are located on the River Rouge, with site comprising close to 1,000 acres of land. The first of four blast furnaces is now operating, while coke ovens, chemical works, gas plant and subsidiary branches of operation will soon be placed in service. The second furnace will be placed in blast at an early date. Space has been provided for four additional blast furnaces, another foundry and other buildings, and these will be constructed in the future. The ore docks were completed some months ago. Production at the plant will be used for the motor car works.

The plant of the Hewitt Steel Corporation, Newark, N. J., has been acquired by the Titan Steel Corporation, recently organized, and in the future will be used for the manufacture of railway equipment of various kinds. The plant was at one time operated by a company known as the Titan Steel Castings Company, and during the war was run by the Hewitt interests for the manufacture of steel shells for the government. It comprises a number of buildings, well equipped, with open hearth furnaces and is valued in excess of $130,000. The new owner is planning for extensive improvement work. The various buildings will be remodeled to accommodate the new line of business and additional equipment installed as required for increased production. The initial output will comprise primarily car trucks and body bolsters. The company is said to have orders on hand to insure full production for some time to come. R. E. Jennings, Jr., is president; S. A. Benner, vice president, and R. E. Gill, secretary. R. E. Jennings, Sr., director and former president of the Carpenter Steel Company, Reading, Pa., and director of the Eastern Steel Company, Pottsville, Pa., is heavily interested in the new company.

The Whitaker-Glessner Company, Wheeling, W. Va., has plans under way for the erection of a new branch fabricating plant at Kansas City, Mo. The company specializes in the manufacture of culverts, tanks and kindred products. The new plant will be five-story and basement, brick and reinforced concrete. This concern was recently merged with the Wheeling Steel & Iron Co. and the La Belle Iron Works under the name of the Wheeling Steel Corporation, capitalized at $100,000,000. The new organization will act as a holding company, and the various divisions will maintain their present identity.

Rhymed Fable

A Pilgrim to Damascus one day found
A Sword of shining steel upon the ground.
"O, Blade, what man hath lost thee from his side?"
The Pilgrim asked. To him the Sword replied:
"Of losing me just one man feels the cost,
But by my edge have many lives been lost."

MORAL

An evil man with dangerous weapons may
Cause ruin and disaster in his day;
And so may man's inventions, if not good,
Destroy man's work which might for years have stood.
Poor bronze will cause you trouble and delay—
Damascus Better Bearings always pay.

Ask for information and quotations on Bearings for every purpose.

DAMASCUS BRONZE CO.
PITTSBURGH

6726 KOPPERS COKE OVENS

IN OPERATION OR UNDER CONSTRUCTION
IN THE UNITED STATES AND CANADA
HAVE AN AGGREGATE ANNUAL
CARBONIZING CAPACITY OF MORE THAN

43,000,000 NET TONS OF COAL

Owner or Operator	Location	Number of Ovens
United States Steel Corporation		
Illinois Steel Company	Joliet, Ill.	280
Illinois Steel Company	Gary, Ind.	700
Tennessee Coal Iron & R. R. Company	Fairfield, Ala.	434
Minnesota Steel Company	Duluth, Minn.	90
Carnegie Steel Company	Clairton, Pa.	768
American Steel & Wire Company	Cleveland, O.	180
National Tube Company	Lorain, O.	208
Woodward Iron Company	Woodward, Ala.	170
Coal Products Mfg. Company	Joliet, Ill.	35
Algoma Steel Corporation, Ltd.	Sault Ste. Marie, Ont.	110
Inland Steel Company	Indiana Harbor, Ind.	130
Republic Iron & Steel Company	Youngstown, O.	143
Bethlehem Steel Company	Sparrows Point, Md.	360
Bethlehem Steel Company	South Bethlehem, Pa.	424
Bethlehem Steel Company	Steelton, Pa.	60
Laclede Gas Light Company	St. Louis, Mo.	56
Cambria Steel Company	Johnstown, Pa.	92
Toledo Furnace Company	Toledo, O.	94
Youngstown Sheet & Tube Company	Youngstown, O.	306
LaBelle Iron Works	Follansbee, W. Va.	94
United Furnace Company	Canton, O.	47
River Furnace Company	Cleveland, O.	204
Brier Hill Steel Company	Youngstown, O.	84
Gulf States Steel Company	Gadsden, Ala.	37
Seaboard By-Product Coke Company	Jersey City, N. J.	165
Minnesota By-Product Coke Company	St. Paul, Minn.	65
Colorado Fuel & Iron Company	Pueblo, Colo.	120
Indiana Coke & Gas Company	Terre Haute, Ind.	30
Dominion Iron & Steel Company, Ltd.	Sydney, N. S.	180
Providence Gas Company	Providence, R. I.	40
Jones & Laughlin Steel Company	Pittsburgh, Pa.	300
Rainey-Wood Coke Company	Swedeland, Pa.	110
Birmingham Coke & By-Products Company	Birmingham, Ala.	50
Donner Union Coke Corporation	Buffalo, N. Y.	150
Domestic Coke Corporation	Fairmont, W. Va.	60
Pittsburgh Crucible Steel Company	Midland, Pa.	100
Chicago By-Product Coke Company	Chicago, Ill.	100
Milwaukee Coke & Gas Company	Milwaukee, Wis.	150

THE KOPPERS COMPANY
PITTSBURGH, PA.
BUILDERS OF BY-PRODUCT COKE PLANTS

Co-operate:—Refer to The Blast Furnace and Steel Plant

Some Pointers on By-Product Coke Oven Operations

CORROSION IN COKE OVENS.

At the annual meeting of the Society of Chemical Industry, at Newcastle, on the 13th inst., W. J. Rees read a paper on "Coke Oven Corrosion," in which it was shown that the presence of salt in coal is an important factor in the life of the oven. It was estimated, from analyses of the washings and drainage water from slack, that in average practice in South Yorkshire about 50 pounds of sodium chloride and 20 pounds of sodium sulphate are carried into the coke oven with each charge of slack. As the internal walls of the oven do not reach a temperature at which salt glazing is rapid, the salt vapor penetrates the brick until a zone is reached where the temperature is high enough for a rapid interaction between vapor and brick, the whole process resulting in the formation of a spongy mass that may "ball" or be dragged away by the moving coal or coke. The presence of a layer of hematite in that portion of the brick where shearing and disintegration take place is apparently due to the formation and penetration of ferric chloride, and its subsequent oxidation. In regard to the substitution of other types of brick, recent improvements in the process of manufacture have resulted in the production of silica bricks which, as American experience has shown, behave satisfactorily under the conditions of coke oven practice.

COKE HANDLING EQUIPMENT.

The coke after being quenched is delivered by quenching cars to the coke wharf, where it is spread out in a comparatively thin layer to facilitate cooling and to permit local quenching of any hot spots. Finger gates and rotary pocket feeders located along the face of the wharf arrest the motion of the coke on the wharf and permit it being fed regularly to a belt conveyor which transfers the coke to the screening station.

Coke Classification and Sizes.

Coke is classified as furnace, foundry or domestic, depending on its chemical and physical properties. Classified approximately as to size, furnace coke is "run-of-oven" coke from which the breeze and other small coke, i. e.: ¾ inch size and under, is removed; foundry coke is a blocky coke, with a maximum size much greater than furnace coke, and from which all sizes under 2½ to 3 inches are removed. Domestic coke, which includes all sizes 3 inch and under, is sub-divided into egg, stove, nut, pea and breeze sizes. Egg coke includes sizes between 2¼ and 3 inches; stove coke includes sizes between 1¼ and 2¼ inches; nut coke includes sizes between ¾ and 1¼ inches; pea coke includes sizes between ⅜ and ¾ inches, and breeze coke includes sizes ⅜ and under. The above classification is an average only and varies slightly at different plants.

Coke Handling and Screening Methods.

Coke handling methods have been greatly improved and simplified during the past few years. Coke being both brittle and very abrasive, is a difficult material to handle. The engineering problems involved are of a very special nature, the solution of which would be undertaken only by an organization with considerable experience in this particular field.

The arrangement and selection of coke handling equipment depends on the kind of coke to be manufactured. In general the plants may be divided into four types—plants producing furnace coke, plants producing foundry and furnace coke, plants producing foundry and domestic coke, and plants producing foundry, furnace and domestic coke.

Where by-product coke plants are constructed in connection with blast furnaces and steel plants, the first type of plant is usually installed. Stationary cascade bar screens or revolving drum screens separate furnace coke from the small sizes. The revolving disc grizzly which has been used for foundry screening is now being used successfully, with small openings, for furnace coke screening. "Run-of-oven" coke is delivered by the conveyor from the wharf to the screens located in a screening station. The coke passing over the screen is delivered by chutes or by boom conveyors to railroad cars, the small coke or breeze passing through the screen being delivered to cars direct or to a belt conveyor which carries it to a reciprocating or revolving drum screen located over bins. This last screen separates the small coke into two sizes and delivers to the bins, the separation giving a better product for burning on the boiler house stokers.

The second type of plant differs from the first only in that a foundry screening and loading station is installed ahead of the furnace screening station. The coal mixture used is such that a larger maximum size of coke is produced.

Domestic coke handling and screening plants, the third type, differ greatly in the layout and arrangement of units, which are influenced by such factors as the location of the plant with reference to the market and by trade conditions, it being necessary in some plants to arrange for loading domestic coke to open top cars, box cars or barges, and for delivering in bags or in bulk to wagons and trucks. This type of plant consists essentially of a foundry screening station and a domestic screening station. The foundry screening station is arranged similarly to that described under the second type of plant except that a coke crusher is generally installed to crush coke to domestic sizes.

The principal difference between the third and fourth types of plants is that the latter has a furnace screen, usually of the rotary grizzly type, although sometimes a cascade bar screen is used.

A modern plant is likely to require a combination of any or all of the above screening and loading facilities and there is practically no limit to the number of possible arrangements. The conditions at each plant must be given careful study and a layout made according to it individual requirements.

J. Van Ackeren, superintendent of the Koppers Company, Pittsburgh, has returned after several weeks inspection trip of European by-products coke plants.

V V

D. T. Haddock, superintendent of the Sharon, Pa., plant of the American Sheet & Tin Plate Co., was presented with a diamond.

V V

William E. Corey, chairman Midvale Steel & Ordnance Co., has returned from a trip abroad.

TRADE NOTES

At the new sheet mill of Follansbee Brothers Company, Toronto, O., the furnaces for the sheet mill will be fired with powdered coal. For transporting the pulverized fuel from the milling plant to the furnace bins, the Quigley air transport system has been adopted. A standard blowing unit of five tons capacity consisting of pulverized fuel bin, blow tank and scales and which is capable of transporting 10 tons of pulverized coal per hour, will be installed. The total distance for transporting fuel is approximately 1,700 feet. This blowing equipment is being furnished by the Quigley Furnace Specialties Company, 26 Cortlandt street, New York City.

Charles H. Breed, until recently metallurgist with the Crown Cork & Seal Co., of Baltimore, Md., has joined the staff of Daniel M. Luehrs, industrial consulting engineers, Cleveland, O., as consulting metallurgist. Mr. Breed will have charge of the metallurgical laboratories.

E. M. Heumann, until recently connected with the chemical department of the Crown Cork & Seal Co., of Baltimore, Md., has joined the staff of Daniel M. Luehrs, industrial consulting engineers, Cleveland, O., as chemist in charge of the chemcial laboratories.

TRADE PUBLICATIONS

"Metal Melting Pots" is the title of a new two-page, 8½x11 illustrated leaflet descriptive of C-H melting pots, both portable and bench types. These heating pots are especially serviceable for melting lead, tin, soldier, babbitt, etc., and maintaining these metals at the proper temperature. The heat may be controlled by means of a rotary snap switch or an automatic control device which maintains the temperature at the desired point. The leaflet is known as Publication 826.

F. A. Calhoun Company announce a new catalogue No. 5, illustrating and describing their line of portable heat-treating furnaces. The catalogue contains 40 pages.

Yarnall-Waring Company have issued a new descriptive folder No. C-805, on "Yarway Pipe Joint and Yarway Holtite Pipe Clamps."

"The Iron Ores of Lake Superior," by Crowell & Murray, industrial chemists and mining engineers, Cleveland; cloth; 301 pages, 6x9 inches; published by the Penton Publishing Company, Cleveland, and supplied by the Iron Trade Review, $5, net.

Bulletin 38. The Roberts & Schaefer Co., Chicago, Ill., pp. 6; 8½x11 in.; illustrated. A description of modern mechanical equipment for the handling of locomotive coal.

"W-S-M Car Dumpers," Wellman-Seaver-Morgan Company, Cleveland, O., publisher. Bulletin 49, pp. 15; 8½x11 in; illustrated. Description of coal car dumping plants at terminals and plants.

"W-S-M Coal and Ore Handling Machinery," Wellman-Seaver-Morgan Company, Cleveland, O. Bulletin 41, pp. 48; 8½x11 in.; illustrated. Description of several types of extensive equipment for unloading open-top cars and for handling coal and ore at terminals and large plants.

"Extension to L Street Station, Boston," by Charles H. Bromley. Distributed by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis., pp. 4; 8½x11 in.; illustrated. Relates how Boston uses the Dean control for the operation of gate valves.

The National Tube Company, Pittsburgh, Pa. Bulletin, pp. 69; 8½x11 in.; illustrated. Description of the various processes of making seamless tubes in the Nationla works. Accounts of tests are given and facts of interest to those using tubes.

"Bearings and Their Lubrication," Vacuum Oil Company, New York, N. Y., publisher. Bulletin, pp. 31; 9x11¼ in.; illustrated. Various types of bearings are noted and lubrication commented upon.

"Portable Conveyors," Portable Machinery Company, Passaic, N. J., publisher. Catalogue, pp. 24; 6¼x9¼ in.; illustrated. Notes money-saving features of certain machinery for storing, reclaiming, loading and unloading loose material such as coal, coke, etc.

"Welding and Cutting Equipment," Davis-Bournonville Company, Jersey City, N. J., publisher. Catalogue ,pp. 15; 3¼x6¼ in.; illustrated. A description of oxy-acetylene and oxy-hydrogen welding and cutting equipment in the manufacture of which this company has been exclusively engaged.

"Roller Bearings, Trucks and Mine Cars," Railway & Mine Supply Co., Chicago, Ill. Bulletin 191, pp. 24; 8½x11 in.; illustrated. A description of the equipment noted in the title of the catalogue together with drawings of cars, on which provision is made for filling in dimensions of equipment desired by possible purchasers.

Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., pp 25; 4x7 in.; illustrated, miniature catalogue 5 A-1. Notes concerning Westinghouse insulating materials and supplies.

"Artesian Waters of Northeastern Illinois," by Carl B. Anderson. State of Illinois, Department of Registration and Education Division of the State Geological Survey, Urbana, Ill Bulletin 34 Illustrated, pp. 326; 7x10 in

"Coal in 1918." Part A. Production By C. E. Lesher. Department of the Interior, Bureau of Mines. II 27 Mineral Resources of the U. S., 1918, part II (page 695—813). Published May 28, 1920 Illustrated; pp. 119; 6x9 in.

"Annual Report of Coal Mines for the Year Ending December 31, 1919, for the State of Washington," by James Bagley, state mine inspector, Seattle, Wash. Not illustrated; pp. 53; 6x9 in. Statistical data and information about the coal mines of the state.

The Chicago Pneumatic Tool Company, with offices in New York, announces the election of Allan E. Goodhue as vice president in charge sales. Mr. Goodhue, since May 1, 1919, has been managing director of the English subsidiary, the Consolidated Pneumatic Tool Company, London, England; also director of European sales for the Chicago Pneumatic Tool Company. Mr. Goodhue was for a number of years connected with the sales department of the Midvale Steel Company and Midvale Steel & Ordnance Company, in Philadelphia, Chicago and Boston, leaving that company in March, 1918, to enter the service of the Government. From that time until January 1, 1919, when he became connected with the Chicago Pneumatic Tool Company, he was assistant manager of the steel and raw material section, production division, of the Emergency Fleet Corporation.

In view of the present great scarcity of fuel and the unusual public interest in the economical consumption of it, the Uehling Instrument Company, 71 Broadway, New York City, has decided to exhibit fuel saving devices at two of the leading expositions of the year, the Chemical show, Grand Central Palace, New York, September 20-25, and the National Association of Stationary Engineers Convention, Milwaukee, Wis., September 13-17.

Yale & Towne Manufacturing Co., Stamford, Conn. Folder pp. 4; 8½x12 in.; illustrated. Announcement of the purchase of the Industrial Electric Truck Division of the C. W. Hunt Company, of Staten Island, N. Y.

Bulletins.

"Electrometallurgical and Electrochemical Industry in the States of Washington," by Charles D. Grier. Engineering Experiment Station, University of Washington. Bulletin 5. Illustrated; pp. 45; 6x9 in.

"Quarry Accidents in the United States During the Calendar Year 1918," by Albert H. Fay. Not illustrated; pp. 52; 6x9 in.

Born under the shadow of the Champion Cranes, Skandia Engines are used world-wide.

Mr. J. H. Hansen, President of The Skandia Pacific Oil Engine Company, writes:

"—this crane has been in operation since the time of installation and has given excellent results. We are in every way very much satisfied with it."

Smooth, unfaltering power, safety and ease of operation—these things are built into every Champion Crane. That's why their owners like them.

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Electric Truck For Sale

One Type "G" Automatic Transportation Company electric truck, serial No. 343. Platform 36" wide by 66" long. Equipped with 36 Edison "A-4" cells. Cells and truck in good condition.

The Eastern Malleable Iron Company,

Naugatuck, Conn.

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FOR SALE

1—Bates Machine Co.
1800 HP single left hand non-condensing Bates Corliss steam engine—34"x60" extra heavy rolling mill type—outboard bearing—with 21'0" dia. flywheel—two 10'0" dia. rope sheaves—2 with 17-2" grooves each—12" steam feed 14" exhaust—fly ball governor, with auto stop—gravity oiling system including contact oilers and pipe and fitting connections.

1—Mesta Machine Co.
24'0" dia. cast iron rope wheel in 4 sections bolted and grooved for 34-2" ropes—shaft 27"x18'0" long.
2—24"x42" adj. pillow blocks
2 cast iron flanged couplings.
31 lengths of 2" rope 160 feet long 70 per cent good.
Delivery approximately six months.

THE CANTON SHEET STEEL COMPANY
of The Hydraulic Steel Co., Canton, O.

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Corliss Engine Units

2—20x36 Hamilton heavy duty Corliss engines each directly connected to 250 kw direct current generators, speed 120 revolutions, complete with switchboard.

1—100 kw Corliss outfit same as above, all 250 volts.

2—Balancer sets, complete.

Pumps, Heaters, Tanks, Boilers, Etc.

H. P. Brearley,

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BLOWING ENGINES
FOR BLAST FURNACES

4 Wetherill Blowing Engines, steam cylinders 36", air cylinders 84" x 60" stroke, will maintain air pressure of 15 pounds, all complete and first class condition. Immediate delivery.

J. F. DONAHOO COMPANY,
BIRMINGHAM, ALA.

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ENGINES

The two following engines must be moved immediately, and we are offering them at sacrifice prices:

1—200 to 400 H. P. Heavy Duty 3-Bearing, Simple Engine, extra heavy.

1—400 to 700 H. P. Heavy Duty Corliss Engine, was used for rolling mill work and is arranged for belt drive and crab connection.

Unusually heavy with 16 inch main shaft and large bearings.

Both engines are in first-class condition and guaranteed.

Wire or Write

Power Equipment Co., Engrs.,
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in First Class Condition
Hydraulic Forging Presses
Blast Furnace Gas Motors
Rolling Mill Equipment
(Blooming, Plate and Universal Mill)
Send Full Particulars and Terms.
No Transactions With Dealers.

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Superintendent of steel mill desires position. Several years experience in strip and billet mills, also open hearth furnaces. References given.

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Four (4) 524 hp. each, Babcock and Wilcox water tube boilers—steel headers, butt-strapped drums, single settings—180 pounds insurance based on factor of safety of 5.5—condition like new—Prompt delivery.

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university training, several years experience in analysis of ores, metals, ferro-alloys and alloy steels. Also experienced in plant research work. Will consider proposition to take charge of laboratory. Will be especially interested in position as assistant to metallurgist or melter.

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Immediate opening for thoroughly experienced designer and checker on rolling mill machinery. Permanent position for competent, energetic man who can produce results. Location, Pittsburgh, Pa. State reference, age, experience and salary expected. Write

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by Englishman at present in Pittsburgh as coke-oven superintendent or similar position. Knowledge of benzol, solvent, toluol, sulphite of ammonia, tar, pitch, creosite, anthracene, etc. Can furnish excellent references. Several years experience in both England and Wales.

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Constant stocks of New and Relaying Rails, Spikes and Bolts. Frogs and Switches. Tell us your requirements.

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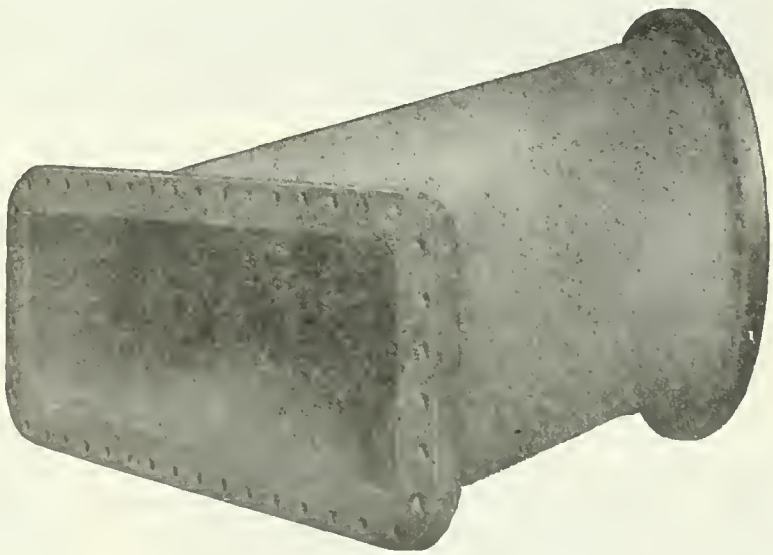

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Note—These products are built and trade-marked by Blaw-Knox Company; Steel Forms for Concrete Construction—Clamshell Buckets—Fabricated Steel Specialties—Water Cooled Appliances for High Temperature Furnaces—Pressed, Riveted and Welded Plate Work—Standardized Sectional Steel Buildings.

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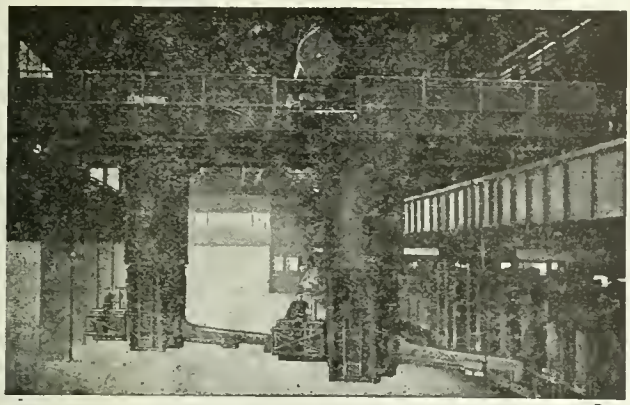

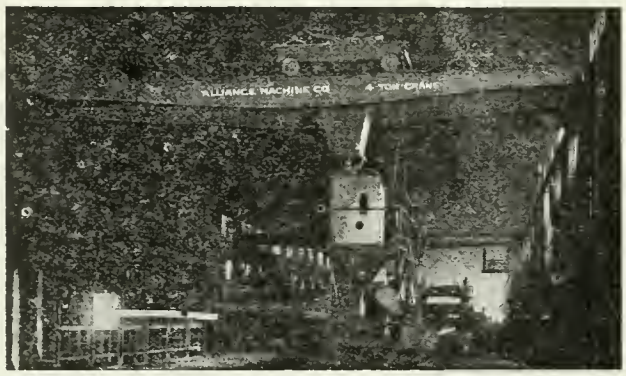

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are the result of our vast experience in handling the difficult and unusual installations in the steel industry. The design and construction of Alliance Cranes, together with mechanical leadership and high grade workmanship have made us the largest manufacturers of the world's largest cranes.

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The World's Largest Builders of the World's Largest Cranes.

ECONOMY renewable FUSES

were the first line using an inexpensive bare link for restoring a blown fuse to its original efficiency to be approved ***In All Capacities*** by the Underwriters' Laboratories. This honor was not won on laboratory tests alone, but largely because for many years millions of Economy Fuses have been giving dependable protection, high efficiency and working marked economies. When you order fuses insist on ECONOMY.

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THE ONLY CENTER JET NOZZLE
Jacket Water
can be easily cooled during the hottest summer months, and the furnace output capacity maintained, if you have installed a SPRACO COOLING POND.
The Spraco Center Jet Nozzle
not only insures CONTINUOUS operation, the four turbine vanes and the center jet, (no other nozzle has it) completely atomize the water and expose the greatest possible surface for cooling effect.
The SPRACO NOZZLE does not merely spray IT ATOMIZES.
Write for Bulletin No. C-8.
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Mfgrs. also of Spraco Air Washers, Spraco Paint Guns and Cement Sprayers, Spraco Nozzles, Vaughan Flow Meters, etc.

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Eliminate the costly sledge hammer method of removing slag and save time, money and labor.

FLEXIBLE SLAG GUN

for removing slag from open hearth pockets. The use of this slag gun means time saved in getting the O. H. back into operation. Operates on air pressure of 75 pounds and up. Strikes a blow far more powerful than sledge. No complicated parts. Easy control. No kick. Write for details today. It will pay for itself in time saved.

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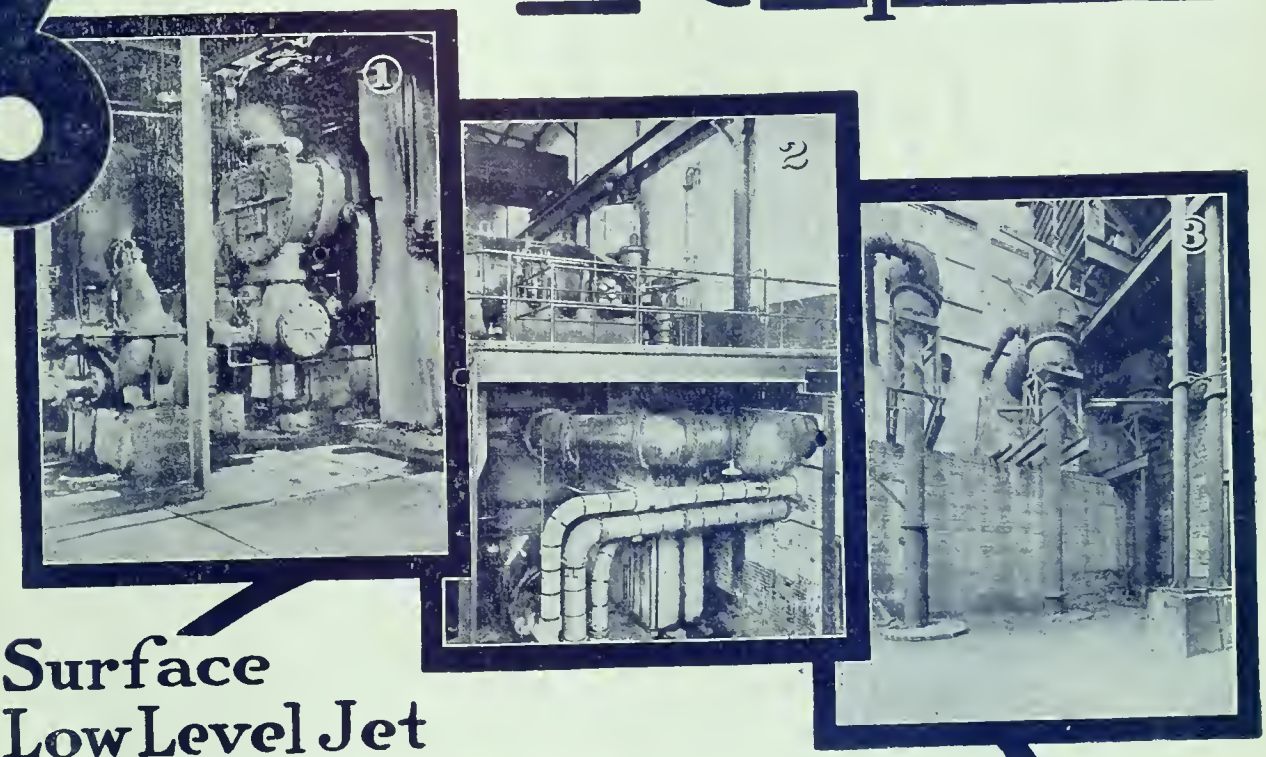

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The chances for satisfactory condenser performance are three to one in favor of the condenser manufacturer who can make his application purely from the angle of plant conditions and requirements.

To have but one type of condenser is a handicap both to the purchaser and the condenser builder. Frequently it results in an unfavorable compromise and an ultimate performance neither satisfactory to the purchaser nor creditable to the condenser manufacturer.

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Bituminous Coal at $18 to $22 or Anthracite (fine sizes) at $4 to $6

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COXE STOKERS

They are being installed under boilers aggregating over 100,000 h. p. in New England right now because of their solution of the above problem.

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Taylor Engineering Co., Vancouver, B. C.

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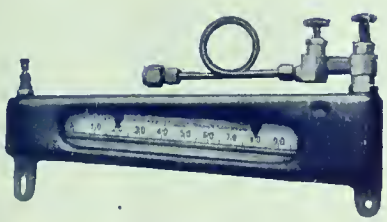
Unshackle your Firemen

Your fireman will tell you that to keep up steam, with a shovel and an uncertain supply of coal of varying quality, keeps him guessing. The real thing which keeps him guessing is his lack of knowledge about what he is doing. He is limited in his well meant efforts by mal-application, hampered at every turn by lack of information, held back because he cannot see the effect of his work except in the aggregate. Guesses impede his progress and annul his best efforts. Dragging this weight around day after day is sure to discourage him—yet

He Is Innocent.

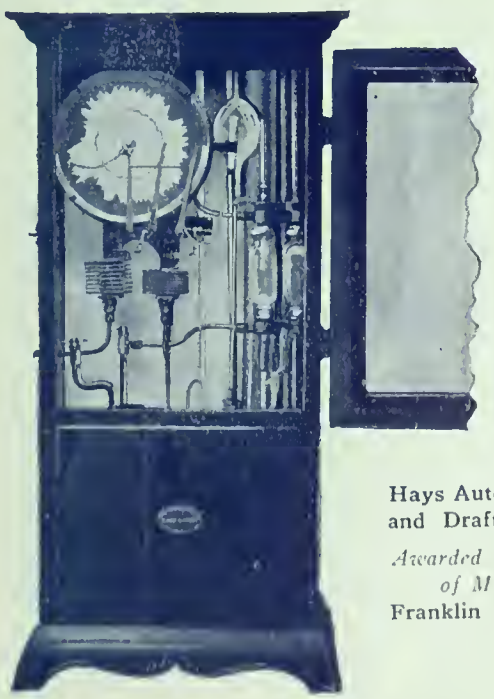


Hays Draft Gage

What he needs is enlightenment—A little interest on your part and HAYS APPARATUS to free him of guess work.

A HAYS DIFFERENTIAL DRAFT GAGE on the boiler front will tell him how much draft he has over the fire. With an IMPROVED GAS ANALYZER he can learn the proper draft and fuel thickness to maintain for different load conditions. And a HAYS AUTOMATIC CO_2 AND DRAFT RECORDER will write the complete story of what happens, pointing out poor practices and faulty equipment, enabling the fireman to maintain a high efficiency and SHOWING YOU how your coal is being burned.

"HAYS SERVICE" guarantees these results. It goes with Hays equipment.



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PUSHING PRODUCTION to meet the demand necessitates the saving of all useless operations about the plant, among which is the constant repacking of piston rods and small valves, which may be avoided by using

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the packing that has the quality that gives long satisfactory service. Such a packing may cost a little more than ordinary packing but is worth it because of the big saving in the labor of frequent application.

Let us send you working samples to test. No charge.

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This packing on exhibition at Milwaukee N. A. S. E. Convention. Call at booth.

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"JOHN CRANE" Channel Packing should be used for Plungers, Accumulators, Presses and any other rods which are subject to vibration or misalignment, or which are slightly fluted or scored.

1 The resilient channel is exceptionally pliable and compressible. It keeps the "JOHN CRANE" metallic packing against the rod, thus sealing the leakage and putting a high polish on the plunger.

2 "JOHN CRANE" flexible metallic insert provides a metal working face. This lubricated metallic insert prevents further scoring and reduces friction to a minimum.

"JOHN CRANE" Channel Packing, Style 400, is recommended for *outside packed plunger pumps,* handling hot or cold water and pressures up to 4000 pounds. It is very successful on *steam hammers, air compressors and ammonia compressors.*

Specify Style 400 on your next order to your local mill supply house

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Reduce Boiler Room Costs!

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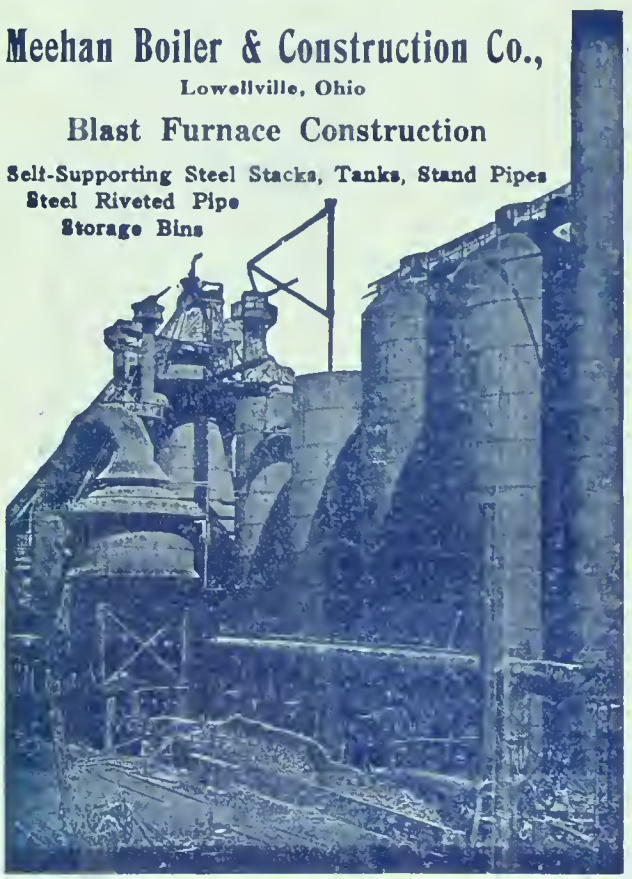
Blast Furnace Construction

Self-Supporting Steel Stacks, Tanks, Stand Pipes
Steel Riveted Pipe
Storage Bins



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MUD GUN HOLDING-DOWN MACHINES

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THREE WAY TUYERE COCKS. Extra Heavy Design.
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We can guarantee to make brass fittings inter-change in every way with ones you have in use.

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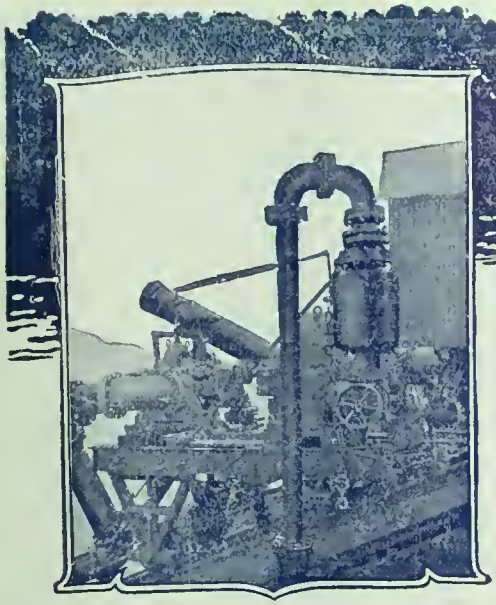


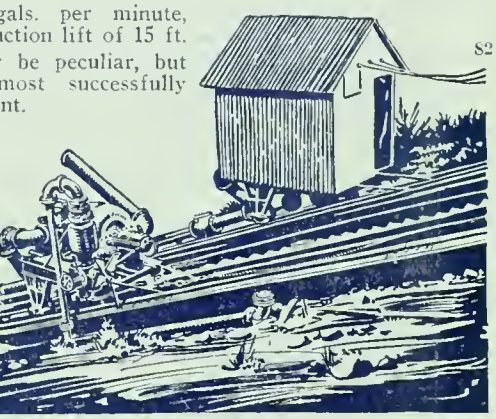
THE ADAPTABILITY OF DE LAVAL CENTRIFUGAL PUMPS

The power plant of a certain mining company is located on the bank of a river which is subject to wide fluctuations in level. To have built a permanent intake in the river connected with a pump shaft of sufficient depth to reach the water at the lowest stage would have been an expensive undertaking, and probably also unsatisfactory, due to shifting of the river bed. Instead sleepers and rails were laid upon the river grade, so that the pumps could be lowered to the water level.

As shown in the photograph, there are two pumps, both De Laval, one driven by a De Laval turbine and the other by an electric motor. The discharge pipes are laid alongside the track with T's at frequent intervals for connection to the discharge of the pump. The steam supply is similarly fitted for connection to the steam turbine.

Each pump supplies 2100 gals. per minute, against 150 ft. total head, with a suction lift of 15 ft.

Your pumping problems may be peculiar, but nevertheless can probably be most successfully solved by using De Laval equipment.



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Ask for Special Catalog B-81

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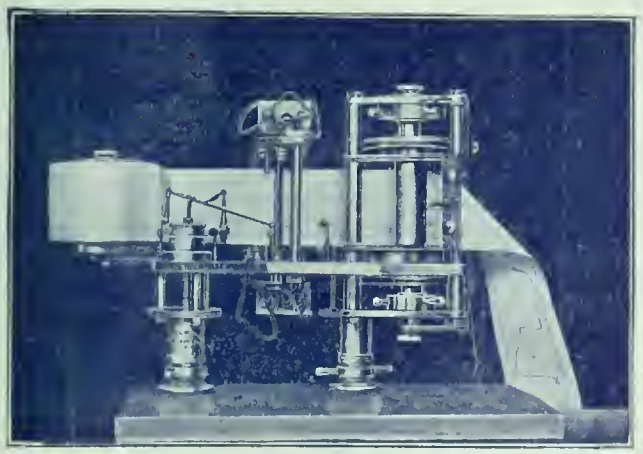
TRENTON, N.J.



Trill Indicators Take
Continuous, Open or Closed Cards

How can you tell just what steam power is being consumed by the Blooming mill in breaking down the ingots, in reversing and ordinary rolling? How can you tell what your gas engine is doing without a reliable tally on the engine effort through these operations?

The "Super" who has a Trill Indicator on his cylinders has a positive index of operation at his finger tips at any time. On rolling mill engines the Trill open card continuous indicator is recommended. It enables easy finding of the reversing point and the cards can be worked out more easily than the closed cards.

The Trill will show you where you are losing money in the engine room and where you can save. Write us today.

Trill Indicator Company
Baker Street, -:- Corry, Penna.

42

Every Ladd Boiler is designed and built with that same painstaking care and thoroughness so characteristic of the Ladd Organization.

Complete details of design, construction and performance are embodied in our latest catalogue. Send for it today.

THE GEORGE T. LADD COMPANY,
First National Bank Bldg., Pittsburgh, Penna.
Chicago Office: 527 McCormick Bldg., Chicago, Ill.

Dirty Boiler Tubes Spell *Waste!*

Soot and ash deposits on the tubes of a boiler inevitably mean wasteful operation—lost coal, low boiler efficiency.

They probably also indicate the presence of other boiler and engine room losses—for failure to remove soot deposits is generally symptomatic—the power plant operator who ignores dirty boiler tubes will ignore other causes of waste.

If you want to keep up steam when soot piles up in your boiler, you will have to pile in more coal.

Diamond Soot Blowers are the one logical solution to the soot problem. They are today in use on many millions of horsepower of boilers. Last year 2,200,000 H. P. of boilers were equipped with Diamonds. For the first six months of 1920 the record is 1,500,000 H. P.

As compared to the best possible results with the hand lance, Diamond Soot Blowers will effect the following economies:

1. FUEL; a saving of 4 to 8%.
2. BOILER EFFICIENCY; an increase of 4%.
3. LABOR; a saving of many hours per day.
4. LONGEVITY; an increase in the length of service of boiler tubes, through the prevention of corrosion.
5. STEAM; a saving of 25 to 75% of steam used for cleaning.

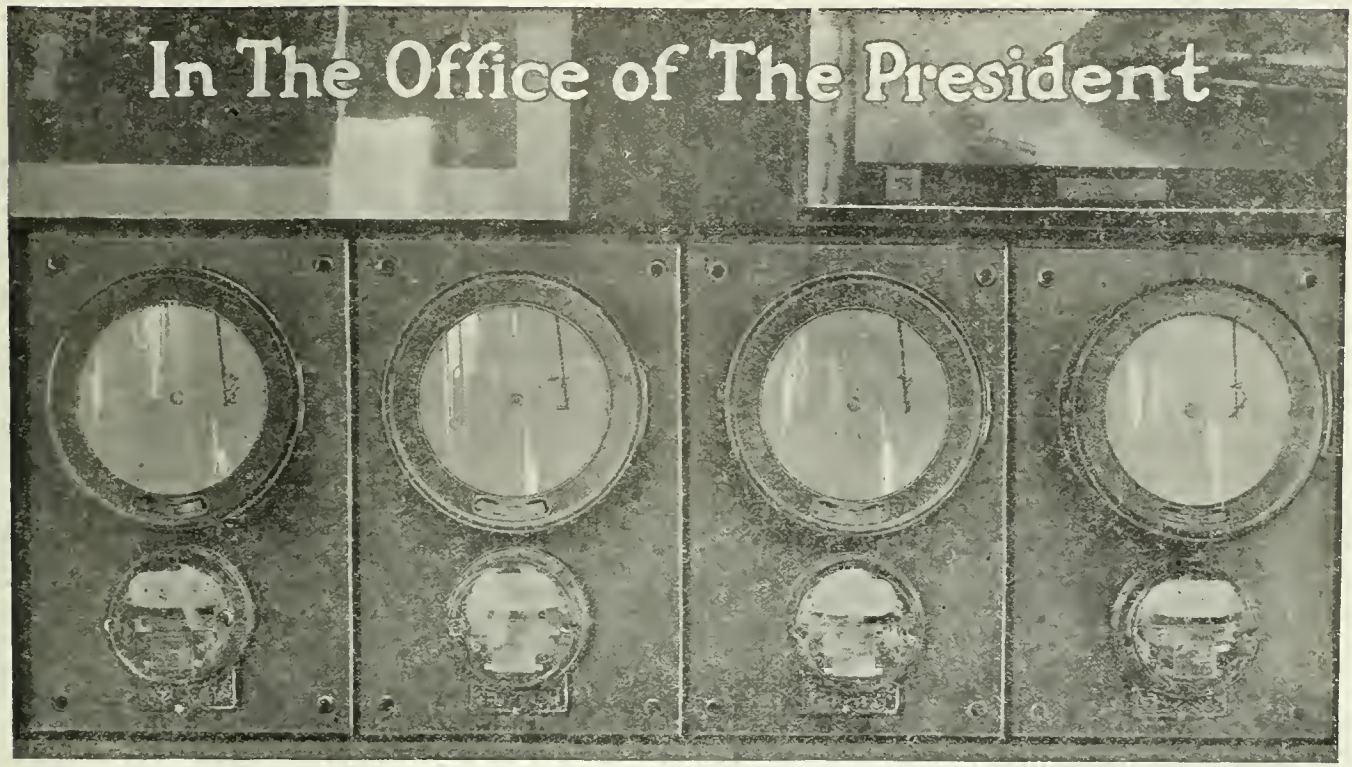
If your boilers are not yet equipped with this money-saving apparatus, ask for Bulletin 250

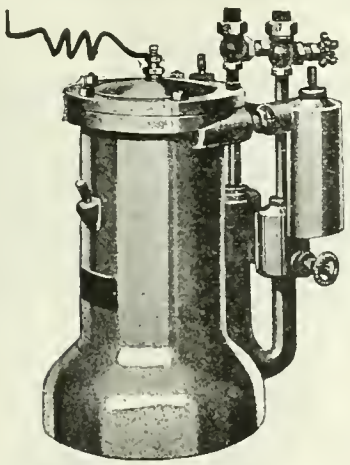
DIAMOND POWER SPECIALTY COMPANY
Detroit, Michigan

Diamond

SOOT BLOWERS - SAVE 4 to 8% FUEL

Co-operate:—Refer to The Blast Furnace and Steel Plant





From Gas Mains To Office

The one way of getting acquainted with the gas consumption plant.

A constant indication, an integrated total, a graphic record of boiler output and steam consumption on three reading instruments—that is the thorough record that is supplied by the conveniently read instruments of a Republic Flow Meter System.

The demand for a Flow Meter which will measure gas or air without introducing and obstruction in the pipe has become so urgent, that the Republic Low Differential Flow Meter has been perfected and marketed.

The Republic possesses a number of important advantages found in no other type of Flow Meter, all of which are the direct result of its exclusive feature—electrical operation. The most important of the advantages are maximum accuracy, no moving parts. flexibility of installation.

Bulletin No. 7 containing further details will be mailed on request.

REPUBLIC FLOW METERS

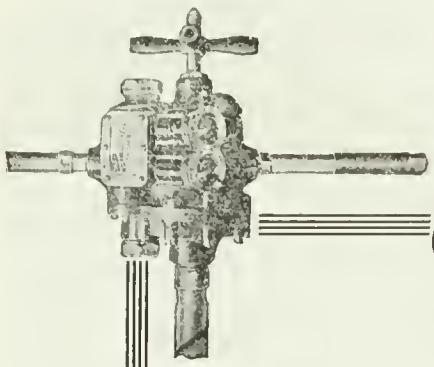
Republic Flow Meter Company

2240 Diversey Blvd., Chicago

Republic System

Branch Offices: New York, Philadelphia, Boston Pittsburgh, Atlanta, Detroit, Toronto, Canada.

Co-operate:—Refer to The Blast Furnace and Steel Plant

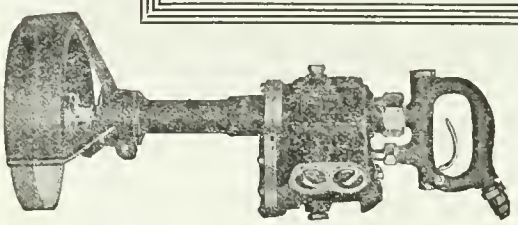


Thor

Thor Pneumatic Tools are created by an organization devoted to the construction of air and electric Tools exclusively. Every THOR PRODUCT—is the successful achievement of an individual function.

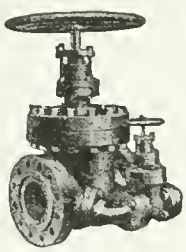
That the satisfaction of the industrial field has been accomplished with Thor Tools is evidenced by the enormous quantities of THOR Products sold during the past two years, to Machine Shops, Boiler Plants, Railroad Shops, Foundries, Shipyards and Automobile Factories, embodying every requirement including floor rammers, bench rammers, air grinders, chipping, calking and flue beading hammers, riveting hammers, drills, electric drills and grinders.

We will gladly send you information on the "THOR LINE" of electrical and pneumatic tools. Write today



Independent Pneumatic Tool Company

Chicago, Pittsburgh, Cleveland, New York, Detroit
Montreal, Birmingham, San Francisco.



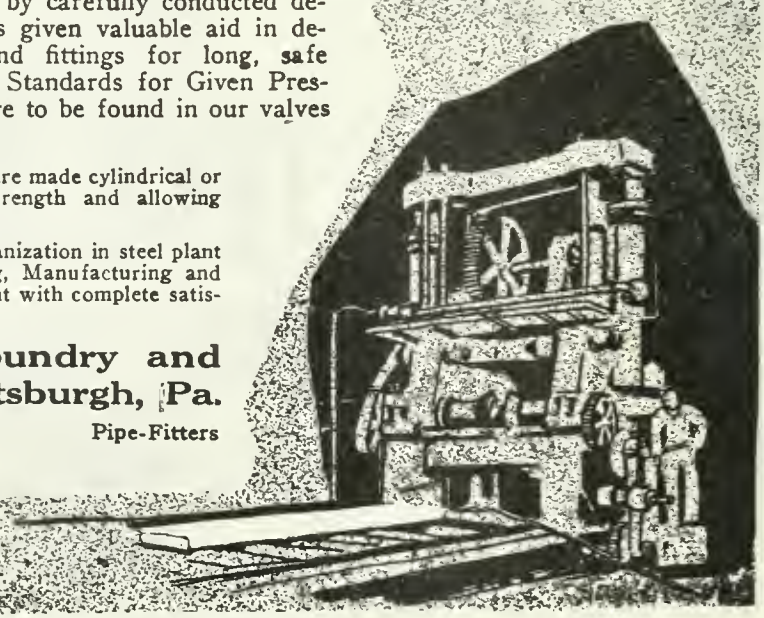
Heavier Standards
For a Given Pressure

Data provided by carefully conducted destruction tests has given valuable aid in designing valves and fittings for long, safe service. Heavier Standards for Given Pressures therefore are to be found in our valves and fittings.

TRADE MARK
ATWOOD

In our hydraulic valves, all surfaces are made cylindrical or spherical segments, giving maximum strength and allowing unrestricted flow within.

With the long experience of our organization in steel plant work you can rely on our Engineering, Manufacturing and Erecting Departments to equip your plant with complete satisfaction.



Pittsburgh Valve, Foundry and Construction Co., Pittsburgh, Pa.

Engineers **Founders** **Machinists** **Pipe-Fitters**

Fuel Oil Fired Kilns

Fuel supply conditions frequently make the use of oil preferable to coal or gas in rotary kilns for manufacturing cement, burning lime, calcining dolomite, or in other processes involving the use of rotary kilns as one of the steps in economical production.

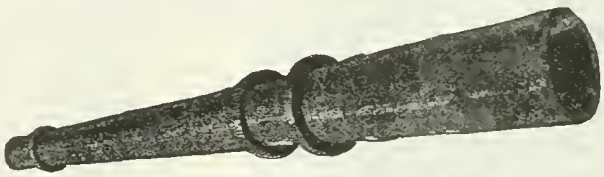
Numerous VULCAN Rotary Kilns have been built to use oil as the fuel. Our engineering staff is prepared to co-operate with yours in designing any type of rotary kiln best adapted to the process for which it is to be used and to the fuel limitations.

VULCAN Rotary Kilns are used in a great variety of industrial processes.

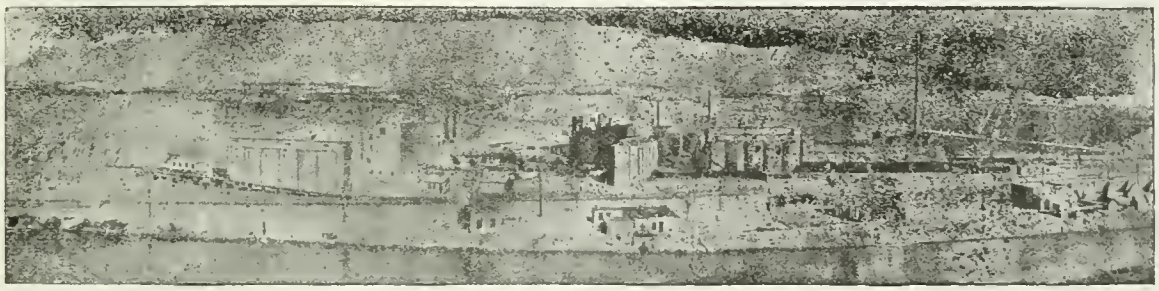
Vulcan Iron Works

Designers and Builders of Rotary Kilns for 20 or More Years.

1755 Main St., Wilkes-Barre, Pa.



VULCAN Rotary Kilns



GENERAL VIEWS OF PLANT OF SOUTH WESTERN PORTLAND CEMENT CO., EL PASO, TEXAS

PORTER

THE UNITED STATES STEEL CORPORATION have nearly 600 PORTER Locomotives in use and they are careful buyers.

H. K. PORTER COMPANY
PITTSBURGH, PA.

LOCOMOTIVES

Co-operate:—Refer to The Blast Furnace and Steel Plant

YARWAY
HYDRAULIC VALVE
(CASKEY PATENTS)

AT THE
American Steel Treaters' Convention
in the Commercial Museum, Philadelphia, September 14th to 18th the Yarway Hydraulic Valve will be on exhibit, together with the Yarway Blow-Off Valve, the Yarway Pipe Clamps, and the Yarway Unloader.

No doubt you will wish to take advantage of this opportunity to examine the Yarway devices. Our representatives at the convention will be glad to give you all possible information and to explain how the Yarway line can help you to secure the utmost efficiency and economy in your plant.

Look for the Yarway Booth.

YARNALL-WARING COMPANY
7610-20 Queen Street,
CHESTNUT HILL, PHILADELPHIA.

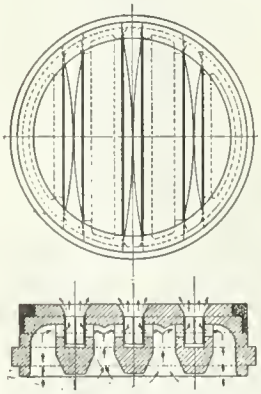
Yarway Hydraulic Valves used to raise and lower open hearth furnace doors. West Penn Steel Co., Brackenridge, Pa.

What can we do to improve the output and efficiency of our Blowing Engine?

By writing to the

Hope Engineering & Supply Co.
Mount Vernon, Ohio. **Pittsburgh, Pa.**

You can get information on the best plate valve ever constructed for high speeds.



The "Biplane" Valve, shown herewith, can be made in larger sizes and gives greater area with low lift than others. Complete heads as well as valves furnished.

Correspondence solicited

"SIMPLEX" SAWS

The Saws That Cut

Day in and day out "SIMPLEX" INSERTED TOOTH SAWS give the same dependable service. No matter how tough the metal to be cut, no matter how severe the cutting strain, "SIMPLEX" SAWS never falter.

The wear resisting qualities of "SIMPLEX" SAWS are due to the high quality Crucible Alloy Steel used in their construction. They are tempered, ground and finished by experts. There is a "SIMPLEX" for every purpose. Let us recommend the saw for your work.

Our booklet on "Pittsburgh" Metal Cutting Saws will interest saw users. Have you a copy?

Pittsburgh Saw and Manufacturing Company
Philadelphia Pittsburgh Detroit

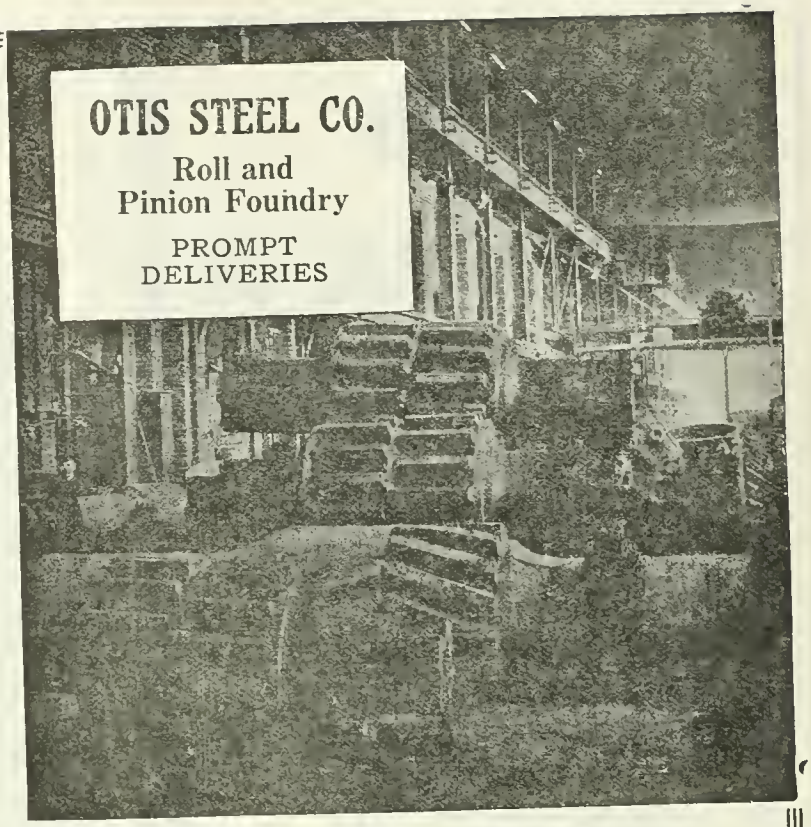
O. H. STEEL
NICKEL STEEL
AND
ALLOY STEEL

PINIONS

Cut or Cast Teeth

Otis Mill Pinions hold the World's Record for Service

We Solicit Your Orders for same quality



THE OTIS STEEL CO., Cleveland, Ohio

Makers of Steel Castings from 1 lb. to 150,000 lbs. each. Rolled Steel Plates and Blue Annealed Sheets

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FOUNDED 1859 ADDY INCORPORATED 1912

The Matthew Addy Co.

Cincinnati, Philadelphia, Chicago,
St. Louis, Pittsburgh.

WE sell iron, coke, coal, Fluor Spar and Alloys, confining ourselves entirely to these great staple raw materials for founders, steel makers and steam plants—No matter where your plant may be located, if you use these things, we can serve you—We shall be pleased to have your inquiries.

Write our nearest office.

FOR SALE
PLANT EQUIPMENT

Excess Upon Rehabilitation

PRACTICALLY UNUSED

—Includes—

4,000 lb. and 700 lb. Forging HAMMERS

LABORATORY, Steel Chemical, Complete

Three Ton and One Ton ELECTRIC FURNACES

Complete With Substations

Four and Six Inch INGOT MOLDS

10″ Carbon and 3″ and 4″ Graphite ELECTRODES

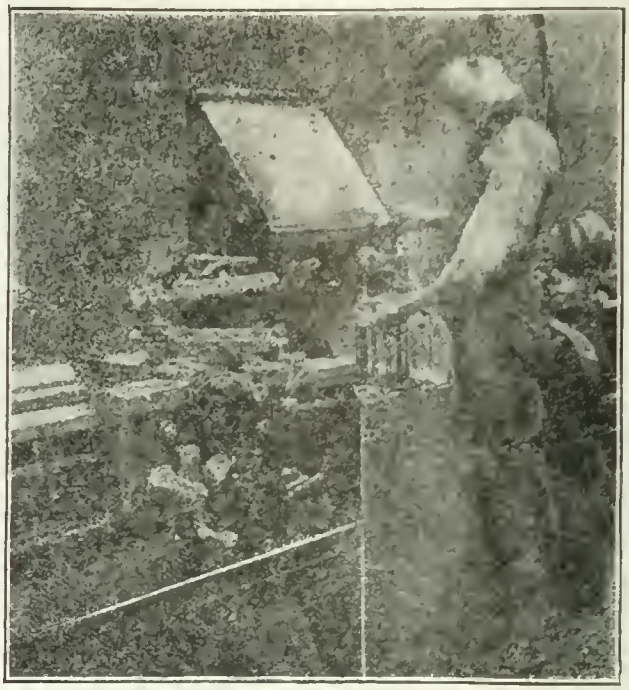
REFRACTORIES and ALLOYS.

Send for detailed list now.

CHICAGO ROLLING MILLS INC.

1203 MAJESTIC BUILDING.
CHICAGO

Prevent Idle Time
of Men and Machines



By placing Bowser Lubricating Oil Cabinets in departments where oil is used.

There is no going back and forth to the oil room, no spilling, no wasted oil, no fire risk from the oil storage.

Save the Oil

The oil supply can be stored and handled as systematically as raw materials or finished parts—income checked, distribution measured, charged and recorded.

Write for literature, explaining why and how Bowser Systems pay for themselves, many times over in saving of oils and labor.

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FORT WAYNE, IND., U. S. A.

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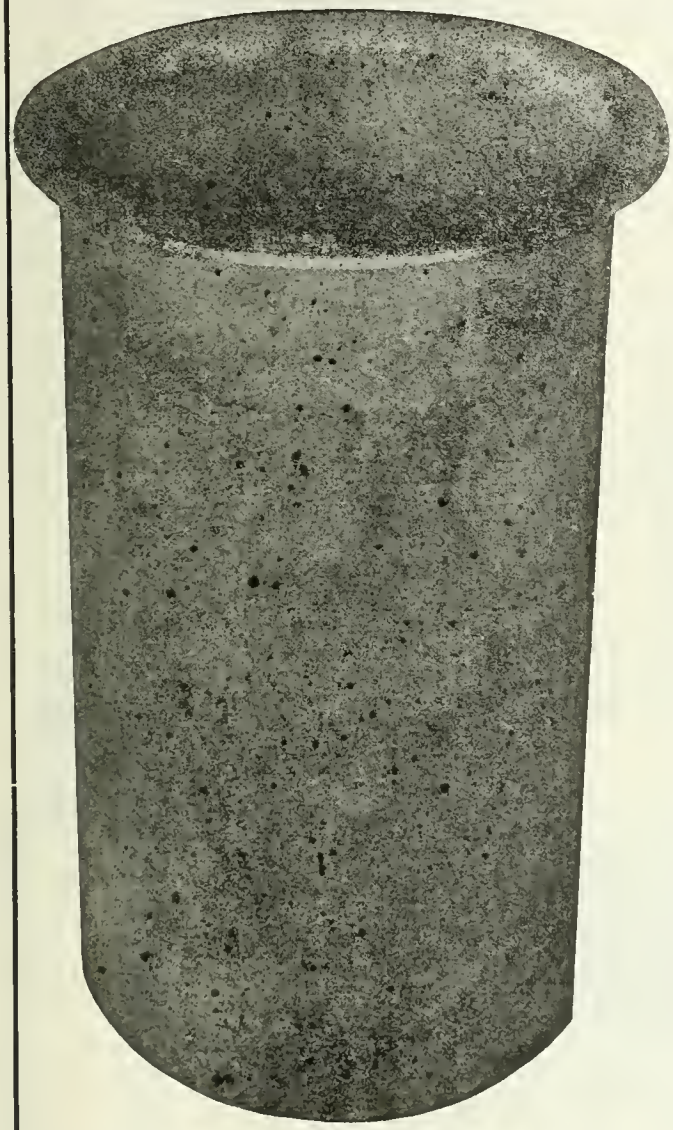
Paris, 5 Rue Denis-Poisson.

Havana, Louja del Comercio 427.

KELLOGG

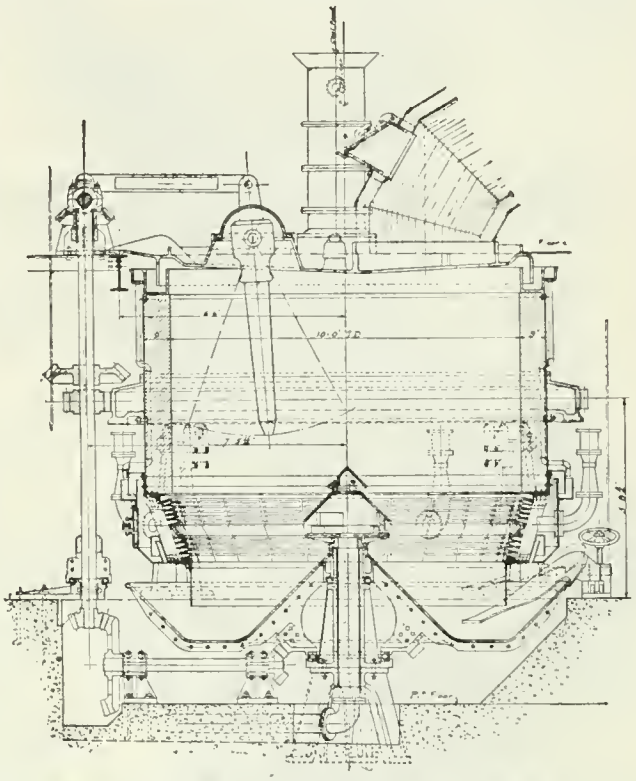


FORGE and HAMMER LAP WELDED ANNEALING POTS

Last Longer and Never Crack

The M. W. Kellogg Co.

140 Cedar St. New York City



Miller Mechanical Gas Producer

Excels in Every Feature

In Blast Distribution
In Operating Economy
In Maintenance Cost

The Result of Thirty Years' Experience.

The NE PLUS ULTRA PRODUCER

Drawings and Description on Application.
Catalog and Cuts in course of Preparation.

Designers and Builders of furnaces of every description for Iron and Steel Trades.

Gas and Air Valves, etc.

The W. R. Miller Company

Headquarters, House Building, Pittsburgh, Pa.
Bell Phone, Court 304.

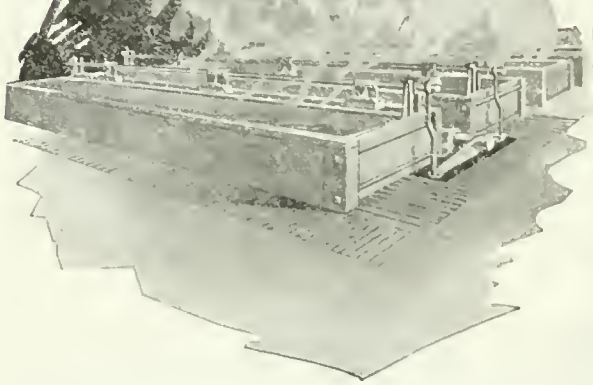
BRIER HILL STEEL CO.

MANUFACTURERS OF

PLATES BLUE ANNEALED SHEETS

PICKLED STOCK

2" THICK AND LIGHTER
72" MAXIMUM WIDTH
222" MAXIMUM LENGTH



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Washed Metal Basic and Bessemer Pig Iron Low Phosphorus Pig Iron Forging and Rerolling Billets Slabs, Sheet and Tin Bar Blue Annealed, Black and Galvanized Sheets Formed Roofing and Siding Single and Double Pickled Sheets Furniture, Automobile and Deep Drawing Stock, etc.

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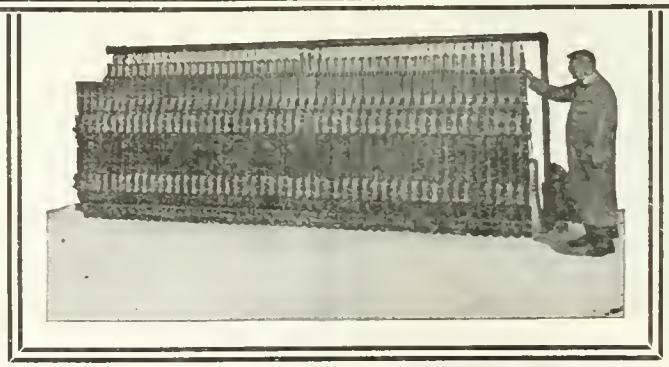
DISTRICT OFFICES
New York, Chicago, Philadelphia, Cleveland, Kansas City, Lynchburg, Pittsburgh, New Orleans, Salt Lake City, San Francisco, San Antonio.

EXPORT AGENTS
Consolidated Steel Corporation, New York City.



Purest Oxygen and Hydrogen at Less Than Half the Cost

Whatever the task, whether you are welding giant shafts or cutting scrap for the melting pot, I. O. C. electrolytic oxygen will add something in speed and efficiency to the operation, and will materially cut your costs.

Generated in your own works. Nearly 300 plants in operation.

INTERNATIONAL OXYGEN COMPANY
NEWARK, N. J.

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I. O. C. Ltd., 38 Victoria Street, Westminster, London, S. W.

ELECTRIC FURNACE CONSTRUCTION CO.

908 CHESTNUT STREET, PHILADELPHIA, PA.

We wish to announce that a new Department has been organized under George P. Mills, late of the General Electric Company. Orders are being executed for electrically heated annealing and heat treating furnaces—also core and mould drying ovens.

The "GREAVES-ETCHELLS" Furnace for "Quality" Steel—the pre-eminent steel-melting furnace.

We cordially welcome members of the Steel Treating Association to Philadelphia and shall be glad to see them at our Exhibition Booth No. 258, or at our offices, 908 Chestnut St.

SEND US YOUR MELTING AND HEAT TREATING PROBLEMS

They Keep Friction on the Run

U. S. G. Co's.

MEXICAN GRAPHITE PRODUCTS

No. 205 Lubricating Graphite for use in your lubricating oil or engine cylinders will cut your friction load and your bearing troubles to the bone.

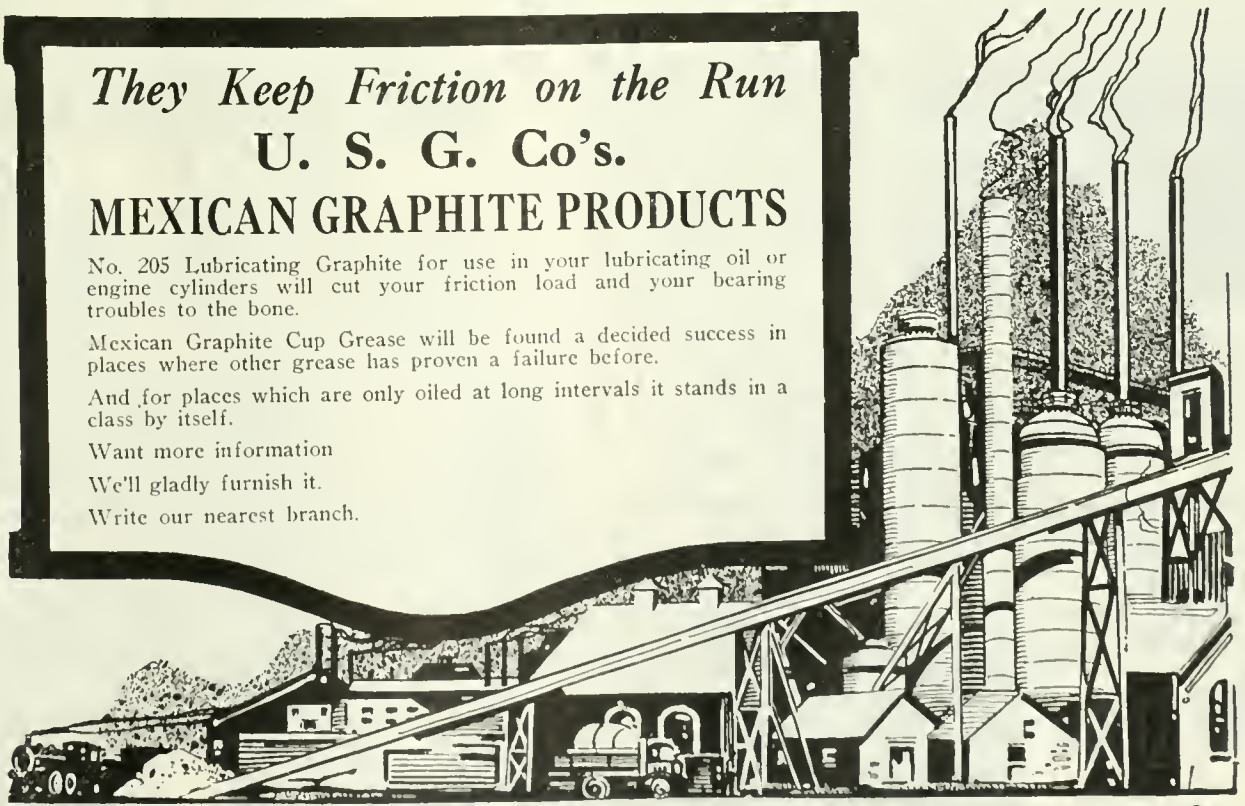
Mexican Graphite Cup Grease will be found a decided success in places where other grease has proven a failure before.

And for places which are only oiled at long intervals it stands in a class by itself.

Want more information

We'll gladly furnish it.

Write our nearest branch.



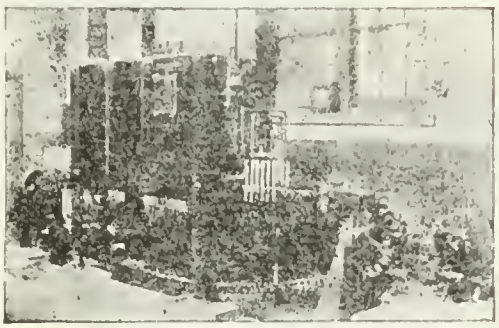
THE UNITED STATES GRAPHITE COMPANY

SAGINAW, MICH., U. S. A.

Branch Offices: New York, Chicago, Philadelphia, St. Louis, Pittsburgh, Denver, Birmingham, San Francisco

LARGEST MINERS OF GRAPHITE ON THIS CONTINENT

Co-operate;—Refer to The Blast Furnace and Steel Plant



Automatic Tube Annealing Furnace
example of "Quantity Production of Quality Product" made possible by use of Automatic Furnace.

AUTOMATIC FURNACES

Will they help ME?

That depends on the kind and quantity of material you handle per day, the regularity of its flow, layout of plant and machinery, fuel available, etc.

Having designed and built hundreds of Automatic Furnaces for many industrial heating requirements, we can help you determine whether the automatic furnace and continuous method of heat-treating would improve your product and lower its cost.

Many interesting applications of the continuous method to the field of industrial heating are shown in Bulletin 217-D. This bulletin illustrates and describes both the furnaces and the heating and handling methods employed in a great variety of manufacturing operations.

Write for copy of bulletin to nearest branch.

Branches: Chicago—Cleveland—Detroit.

We make Industrial Heating Furnaces for Every Requirement.

"FURNACE AND FUEL TO SUIT THE WORK"

W. S. ROCKWELL CO. INDUSTRIAL FURNACES NEW YORK

CUT GEARING

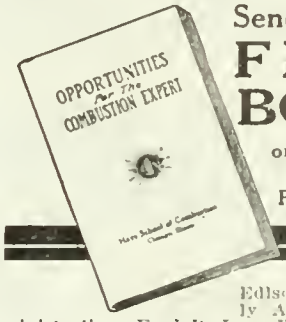
Spur, Bevel and Worm Gearing

———MADE FROM———

CAST STEEL, FORGED STEEL,
CAST IRON, BRASS, RAWHIDE
Etc., Etc.

Builders of special machinery.
Special attention to quick repair work.

The Simonds Manufacturing Co.
Pittsburgh, Pa.



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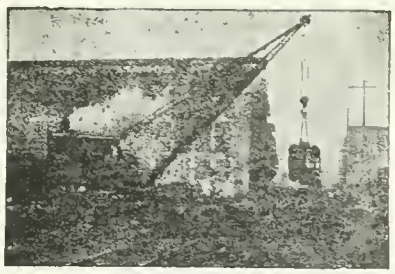
FREE BOOK
on Combustion Engineering Fuel-Economy

THE demand for fuel experts, with the ever-increasing price of coal and oil, was never as great as now. Combustion Experts make big money. The Hays Course in Combustion Engineering has been prepared in simple style at a very moderate fee by the leading fuel experts—Joseph W. Hays, Educational Director, Hays School; W. L. Abbott, Chief Operating Engineer of the Commonwealth Edison Company; Joseph Harrington, formerly Administrative Engineer, U. S. Fuel Administration; Fred R. Low, Editor of "Power"; Prof. S. W. Parr, Department of Chemistry, University of Illinois; David Moffat Myers, formerly Advisory Engineer of U. S. Fuel Administration, Washington, D. C.; Arthur L. Rice, Editor of "Power Plant Engineering"; J. E. Moultrop, Construction Bureau, Edison Electric Illuminating Company. Get into the Combustion Expert class now while the real opportunity exists. Send for FREE book and further details today. **HAYS SCHOOL OF COMBUSTION, 1412-14 So. Michigan Ave., Chicago, Ill., Dept. 70-B.**



O. S.
DEPENDABLE
Locomotive Cranes

The Orton & Steinbrenner Locomotive Cranes are built to stand hard and continuous service. Their rugged construction and durability have been proven time and again in the severe steel mill service. Write us for details and let us help you make profits by the economical handling of your material. Do not take chances in tying up expensive equipment by purchasing inferior unloading devices.

Orton & Steinbrenner Co., Chicago, Ill.
Factory: Huntington, Indiana.

PULVERIZED COAL EQUIPMENT

AERO PULVERIZER CO.
120 Broadway, N. Y.

Cooling Water

With Sprays

Why not write us today.

101 Park Ave
New York

E. B. BADGER & SONS CO.
67 Pitts Street, Boston

616 S. Michigan Ave.
Chicago

Wherever Steel is Made, Safety Demands these Devices

The
BURRELL
Gas Mask
(*Hose Type*)

When a Gas Mask is needed there is no protection like the BURRELL.

It fits close to the face, light and comfortable to wear. No mouthpiece nor nose clip, large clear vision goggles—see, hear and talk distinctly.

This BURRELL Hose Type Mask is adapted to many uses. No canister needed; just leave the hose end in the open air—work protected in any kind of gases, smoke and fumes. It is a real working mask. Send for descriptive booklet.

Call, telephone or write.

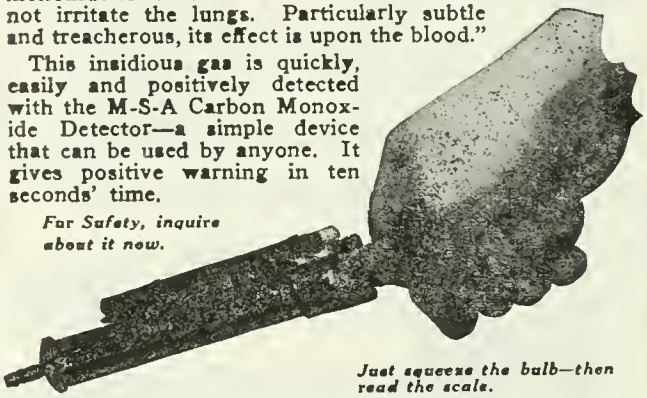
Immediate Shipment.

M-S-A Carbon Monoxide Detector

"Carbon Monoxide—responsible for more deaths than all other gases combined. Deadly carbon monoxide is itself almost odorless. It does not irritate the lungs. Particularly subtle and treacherous, its effect is upon the blood."

This insidious gas is quickly, easily and positively detected with the M-S-A Carbon Monoxide Detector—a simple device that can be used by anyone. It gives positive warning in ten seconds' time.

For Safety, inquire about it now.



Just squeeze the bulb—then read the scale.

Mine Safety Appliances Company

Chamber of Commerce Building, PITTSBURGH, PA.

Commerce Bldg., Pittsburg, Kan.	154 N. 13th St., Philadelphia, Pa.	606 Post St., Seattle, Wash.	403 Monadnock Blk., Chicago, Ill.
208 Market St., San Francisco, Cal.	82 Fulton St., New York.	4226 King St., Denver, Colo.	1st Nat. Bank Bldg., Benton, Ill.
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"Everything for Mine and Industrial Safety"

Nuttall Gears

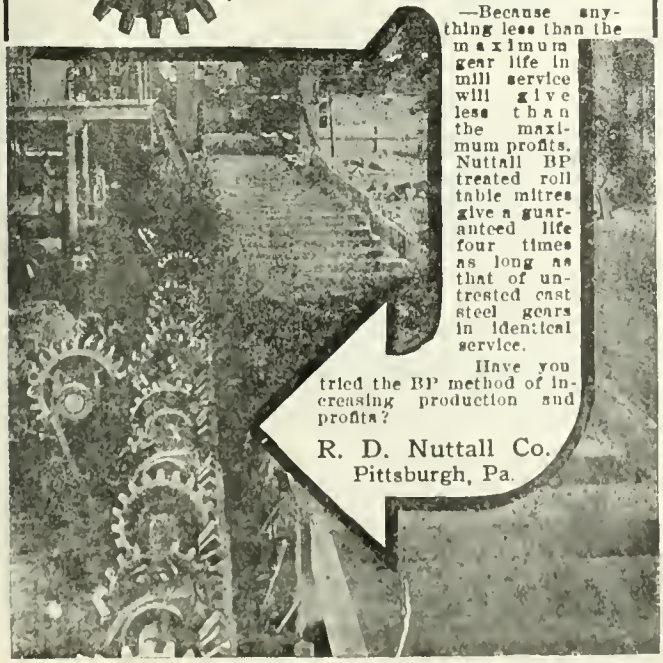
PINIONS, FLEXIBLE COUPLINGS, MINE & INDUSTRIAL TROLLEYS.

THE STRONGEST GEARS THAT YOU CAN GET ARE WHAT YOU NEED TO DRIVE THE ROLLS

—Because broken teeth on roll table gears decrease efficiency and production, and multiply costs.

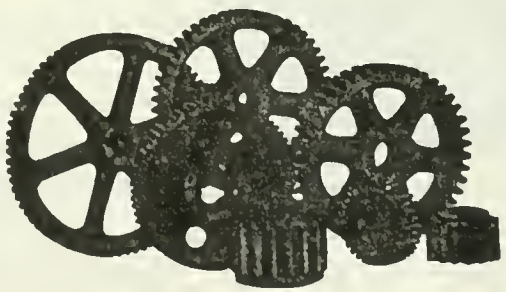
—Because anything less than the maximum gear life in mill service will give less than the maximum profits. Nuttall BP treated roll table mitres give a guaranteed life four times as long as that of untreated cast steel gears in identical service.

Have you tried the BP method of increasing production and profits?



R. D. Nuttall Co.
Pittsburgh, Pa.

TAYLOR-WILSON GEARS



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is saved by hundreds of concerns who use our blast gate. Can YOU afford to overlook such economy?

This New Air-Tight Blast Gate easily supersedes heavy, cumbersome, expensive, and slow-acting gate valves and stop cocks. Costs much less, saves time and labor, and the simple construction eliminates wear and tear.

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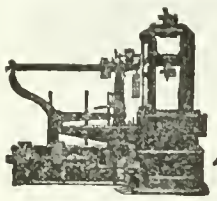

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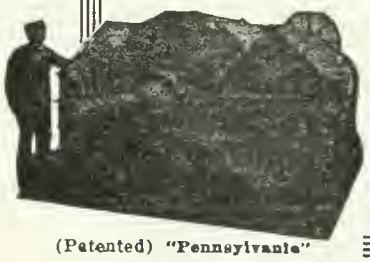
Bradford Coal Cleaners for cleaning bituminous coals and reclaiming "gobbed" coals.



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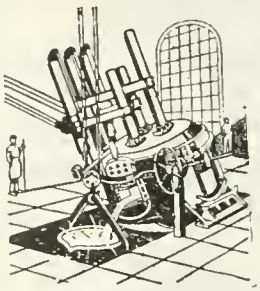

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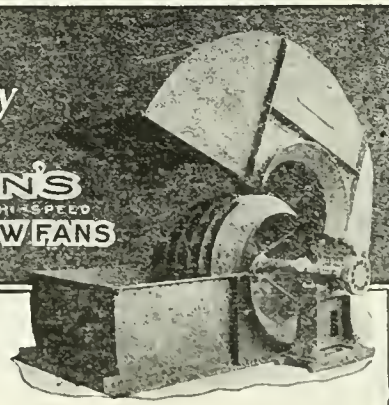

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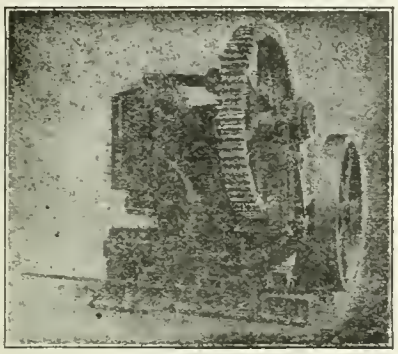

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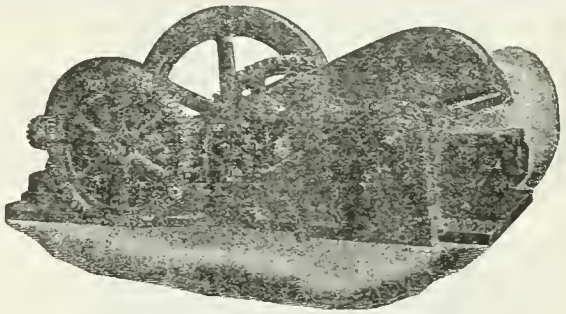

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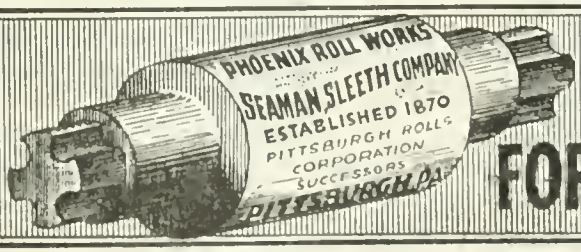

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Blaw-Knox Co.
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Chambersburg Engineering Co.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Niles-Bement-Pond Co.
United Eng. & Foundry Co.

Acid-Proof Products.
King-Karbo Products Corp.

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Pittsburgh Iron & Steel Fdys. Co.
United Eng. & Fdy. Co.

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Blaw-Knox Co.
Chapman Eng. Co.

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General Electric Co.
Hope Eng. & Supply Co.
Ingersoll-Rand Co.
Mesta Machine Co.

Air Coolers.
Badger, E. B., & Sons Co
Spray Engineering Co.

Air Valves.
Blair Engineering Co.
Felix McCarthy.
Hope Eng. & Supply Co.
Yarnall-Waring Co.

Air Washers.
Spray Engineering Co.

Air Cooling Equipment.
Badger, E. B., & Sons Co.

Air Washing Equipment.
Badger, E. B., & Sons Co.

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Whiting Foundry Equipment Co.

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Keystone Bronze Co.
Metal & Thermit Corp.
Otis Steel Co., The.
Quigley Furnace Specialties Co.
U. S. Reduction Co.
United Smelting & Aluminum Co.

Alloys—Vanadium and Special.
Metal & Thermit Corp.

Aluminum.
Aluminum Co. of America.
United Smelting & Aluminum Co.
U. S. Reduction Co.

Anderson Couplers.
Chapman Valve Mfg. Co., The.

Ammonia Recovery Apparatus.
The Koppers Co.

Analyzers.
The Jos. W. Hays Corp.

Annealing Boxes.
American Steel Foundries.
Biehl Iron Works, Inc.
Birdsboro Steel Fdy. & Mch. Co.
Blaw-Knox Co.
Mesta Machine Co.
Quigley Furnace Specialties Co.
United Eng. & Fdy. Co.

Annealing Furnaces and Ovens.
Electric Furnace Constr. Co.
Leeds & Northrup Co.
Rockwell Co., W. S.
Whiting Foundry Equipment Co.

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Kellogg, M. W. Co., The.
Quigley Furnace Specialties Co.

Annealing Pots—Lap Welded.
Kellogg, M. W. Co., The.
Quigley Furnace Specialties Co.

Appliances—Safety.
Mine Safety Appliances Co.

Appliances—Steel Works.
Blair Engineering Co.
Felix McCarthy.

Arches—Flat Suspended.
M. H. Detrick Co.

Ash Handling.
M. H. Detrick Co.
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Edw. P. Terry Mfg. Co.

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Babcock & Wilcox Co., The.
Westinghouse Electric & Mfg. Co.

Automatic Stokers.
Murphy Iron Works.

Bakelite Micarta Gearing.
Nuttall, R. D. Co.

Babbitt Metal.
Allan & Son, A.
Keystone Bronze Co.
Lubricating Metal Co.

Baffles.
The Engineer Co.

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West Leechburg Steel Co.

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Medart Patent Pulley Co.
Shuster Co., F. B.

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Kratzer & Co., W. N.

Bearings and Bearing Metal.
Damascus Bronze Co.
Keystone Bronze Co.
Lubricating Metals Co., The.
United Smelting & Aluminum Co.

Bearings—Roller.
American Roller Bearing Co.
Hyatt Roller Bearing Co.

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Chain Belt Co.
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Morse Chain Co.

Belting—Silent Chain.
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The Koppers Co.

Billets—Steel.
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Blast Furnaces.
McKee Co., Arthur G.
Meehan Boiler & Constr. Co.

Blast Gates.
Rockwell, W. S. Co.
Quigley Furnace Specialties Co.

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Blowing Engines.
Hope Eng. & Supply Co.

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Ladd Co., Geo. T.
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Quigley Furnace Specialties Co.

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Yarnall-Waring Co.

Boiler Tubes.
American Tube & Pipe Bend. Co.
Youngstown Sheet & Tube Co.

Boilers—Water Tube.
Babcock & Wilcox Co., The.
Ladd Co., Geo. T.
Meehan Boiler & Construction Co.
Wickes Boiler Co.

Bolts.
Oliver Iron & Steel Co.

Bonding Material Fire Brick Cement.
Clinton Metallic Paint Co.
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Boxes — Annealing Furnace and Oven.
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Birdsboro Steel Fdy. & Mch. Co.
Blaw-Knox Co.
Meehan Boiler & Construction Co.
Mesta Machine Co.
Quigley Furnace Specialties Co.
United Engineering & Fdy. Co.

Box Car Loaders.
Link-Belt Company.

Brass Cocks.
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Pennsylvania Crusher Co.

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Brakes—Disc.
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Cutler-Hammer Mfg. Co.

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Amer. Enameled Brick & Tile Co.
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Bessemer Brick Co.
Harbison-Walker Ref. Co.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Pyro Clay Products Co.
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Brick—Blast Furnace.
Amer. Enameled Brick & Tile Co.
American Refractories Co.
Ashland Fire Brick Co.
Bessemer Brick Co.
Brighton Fire Brick Co.
Clearfield Fire Brick Co.
Dover Fire Brick Co.
Eureka Fire Brick Works.
Harbison-Walker Ref. Co.
Hydraulic Press Brick Co.
Kier Fire Brick Co.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Paterson Fire Brick Co.
Pyro Clay Products Co.
Soisson Fire Brick Co., Jos.

Brick—Boiler Settings.
Amer. Enameled Brick & Tile Co.
American Refractories Co.
Ashland Fire Brick Co.
Bessemer Brick Co.
Brighton Fire Brick Co.
Clearfield Fire Brick Co.
Dover Fire Brick Co.
Harbison-Walker Ref. Co.
Hydraulic Press Brick Co.
Kier Fire Brick Co.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Paterson Fire Brick Co.
Pyro Clay Products Co.
Soisson Fire Brick Co., Jos.
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Brick—Fire.
Amer. Enameled Brick & Tile Co.
American Refractories Co.
Ashland Fire Brick Co.
Bessemer Brick Co.
Brighton Fire Brick Co.
Clearfield Fire Brick Co.
Crescent Refractories Co.
Dover Fire Brick Co.
Eureka Fire Brick Works.
Harbison-Walker Ref. Co.
Hydraulic Press Brick Co.
Kier Fire Brick Co.
Manown Mfg. Co.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Pyro Clay Products Co.
Soisson Fire Brick Co., Jos.
Taylor, Chas., The Sons Co.

Brick—Heat Insulating.
Amer. Enameled Brick & Tile Co.
Bessemer Brick Co.
Celite Products Co.
Eureka Fire Brick Works.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Pyro Clay Products Co.
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Brick—Locomotive Fire.
Amer. Enameled Brick & Tile Co.
Bessemer Brick Co.
Clearfield Fire Brick Co.
Dover Fire Brick Co.
Harbison-Walker Ref. Co.
Hydraulic Press Brick Co.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Pyro Clay Products Co.
Taylor, Chas., The Sons Co.

Brick—Nozzles, Sleeves and Runner.
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Bessemer Brick Co.
Manown Mfg. Co.
Mt. Union Refractories Co.
Mutton Hollow Fire Brick Co.
Pyro Clay Products Co.

Boiler Feed Purification.
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Quigley Furnace Specialties Co.

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Blaw-Knox Co.
Browning & Co., Victor R.
Edgar E. Brosius.
Link-Belt Company.
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Buckets—Elevator.
Link-Belt Company.

Buckets—Foundry and Construction, Mixing and Bottom Dumps.
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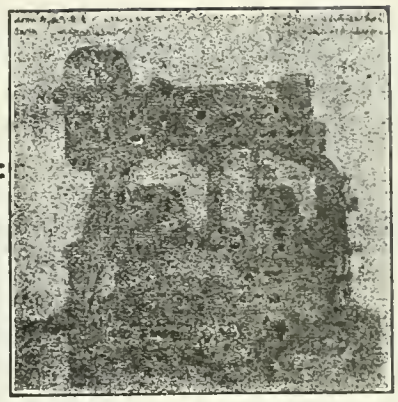

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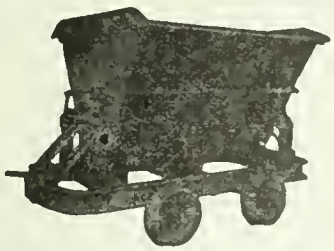

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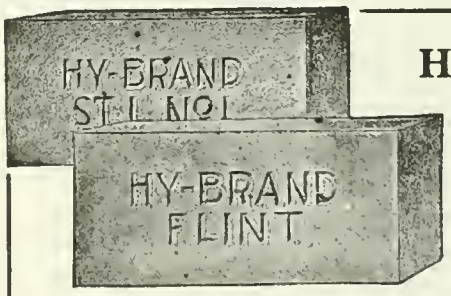
READING, PA.



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The Buyers' Guide

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Garrison Foundry Co., A.
Morgan Construction Co.

Buoys.
Riter-Conley Co.

Burners—Gas and Oil.
Rockwell Co., W. S.

Burners—Powdered Coal.
Quigley Furnace Specialties Co.
Stroud, E. H. & Co.

By-Product Coke and Gas Oven Plants.
Koppers Co., The.

Cages—Hoisting.
R. H. Beaumont Co.
Link-Belt Company.

Caissons.
Riter-Conley Co.

Carbon Brushes.
Speer Carbon Co.

Carbon Dioxide Recorders.
The Jos. W. Hays Corp.

Carbon Monoxide Analyzers.
The Jos. W. Hays Corp.

Cars—Dump.
R. H. Beaumont Co.
Biehl Iron Works.
Clark Car Co.
Easton Car & Construction Co.
Link-Belt Company.
Penn Foundry & Mfg. Co.
Treadwell Engineering Co.
Whiting Foundry Equipment Co.
Youngstown Fdy. & Mch. Co.

Cars—Extensive Side Dump.
Clark Car Co.

Cars—Forging and Charging Box.
Easton Car & Construction Co.
Treadwell Engineering Co.

Cars—Hot Metal.
Blaw-Knox Co.
Easton Car & Construction Co.
Meehan Boiler & Construction Co.
Treadwell Engineering Co.
Youngstown Fdy. & Mch. Co.

Cars—Ingot—Slag—Billet.
Birdsboro Steel Fdy. & Mch. Co.
Easton Car & Construction Co.
Treadwell Engineering Co.

Cars—Industrial.
Biehl Iron Works, Inc.
Easton Car & Construction Co.
Penn Foundry & Mfg Co.
Treadwell Engineering Co.
Whiting Foundry Equipment Co.
Youngstown Fdy. & Mch. Co.

Cars — Ingot and Open Hearth Charging.
Treadwell Engineering Co.

Cars—Ladle Transfer.
Easton Car & Construction Co.
Treadwell Engineering Co.
Youngstown Fdy. & Mch. Co.

Cars—Storage Battery.
Stroud, E. H. & Co.

Car Tanks.
Riter-Conley Co.

Case Hardening Boxes.
Quigley Furnace Specialties Co.

Case Hardening Compound.
Quigley Furnace Specialties Co.

Castings—Annealed, Semi-Steel.
McLain's System, Inc.

Castings.
American Steel Foundries.
Birdsboro Steel Fdy. & Mch. Co.
Camden Iron Works.
Chambersburg Engineering Co.
Duquesne Steel Foundry Co.

Coke Breeze.
Combustion Eng. Corp.
Garrison Foundry Co., A.
Link-Belt Company.
Mesta Machine Co.
National Roll & Foundry Co.
Otis Steel Co., The.
Penn Foundry & Mfg. Co.
Phillips & McLaren Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Eng. & Fdy. Co.
Valley Mould & Iron Corp.
Wheeling Mold & Foundry Co.

Castings—Brass and Bronze.
Damascus Bronze Co.
Keystone Bronze Co.
Mesta Machine Co.
Morgan Engineering Co.

Castings—Chill.
McLain's System, Inc.

Castings—Electric Steel.
American Steel Foundries.
Birdsboro Steel Fdy. & Mch. Co.
Treadwell Engineering Co.
Wheeling Mold & Foundry Co.

Castings—Electric Process.
Treadwell Engineering Co.

Cast Steel Gate Valves.
Chapman Valve Mfg. Co., The.

Castings—Gear.
American Steel Foundries.
Birdsboro Steel Fdy. & Mch. Co.
Chambersburg Engineering Co.
Duquesne Steel Foundy Co.
Garrison Foundry Co., A.
Link-Belt Company.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Pittsburgh Iron & Steel Fdys. Co.
Standard Engineering Co.
Taylor-Wilson Mfg. Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.
Wheeling Mold & Foundry Co.

Castings—Semi-Steel.
Camden Iron Works.
Duquesne Steel Foundry Co.
McLain's System, Inc.

Castings—Gray Iron and Steel.
Garrison Foundry Co., A.
Link-Belt Company.
Morse Chain Co.
Otis Steel Co., The.
Penn Foundry & Mfg. Co.
Nuttall & Co., R. D.
Taylor-Wilson Mfg Co.
Treadwell Engineering Co.

Castors—Plate Mill.
Edw. F. Terry Mfg. Co.
Treadwell Engineering Co

Cells—Generators, Hydrogen and Oxygen.
International Oxygen Co.

Cement—Fire Brick.
American Refractories Co.
Botfield Specialties Co.
Clinton Metallic Paint Co.
Crescent Refractories Co.
Quigley Furnace Specialties Co.

Cement—Furnace—High Temperature.
Clinton Metallic Paint Co.
Quigley Furnace Specialties Co.

Cement—Pipe.
United States Graphite Co., The.

Central Station Equipment.
Allis-Chalmers Mfg. Co.
Morgan Construction Co.
Smith Gas Engineering Co.
Westinghouse Electric & Mfg. Co.

Chains—Agricultural.
Link-Belt Co.
Morse Chain Co.

Chains—Automobile, Engine.
Link-Belt Co.
Morse Chain Co.

Chain Blocks.
Morse Chain Co

Chains—Bicycle (Twin Roller)
Morse Chain Co.

Chain Grates.
Hagan, Geo. J. Co.

Chains.
Link-Belt Company

Chain—Power Transmission.
Chain Belt Co.
Link-Belt Company.
Morse Chain Co.

Chain Drives.
Chain Belt Co.
Link-Belt Company.
Morse Chain Co.

Chains—Sprocket Wheel.
Link-Belt Co.
Morse Chain Co.

Chains—Silent.
Link-Belt Co.
Morse Chain Co.

Channels.
Kratzer & Co., W. N.

Charcoal Iron.
American Tube & Pipe Bend. Co.

Charging Buggies.
Treadwell Engineering Co.

Charging Boxes.
Riter-Conley Co.

Check Valves.
Chapman Valve Mfg. Co., The.

Chimneys—Steel.
Kratzer & Co., W. N.

Chrome.
Harbison-Walker Refractories Co.

Chrome Brick.
American Refractories Co.

Chromium.
Metal & Thermit Corp.

Circulating Systems for Lubricating Oil.
Bowser & Co., Inc., S. F.

Clamps—Flanging.
Chambersburg Engineering Co.
Niles-Bement Pond Co.
Yarnall-Waring Co.

Clutches—Magnetic.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Coal.
Combustion Eng. Corp.
McKeefrey & Co.
Pittsburgh Coal Co.
Stewart Iron Co.
Matthew Addy Co., The.

Coal and Ash Handling Machinery.
Link-Belt Company.
Edw. F. Terry Mfg. Co.

Coal and Ore Handling Machinery.
Link-Belt Company.
Terry, Edward F., Mfg. Co.

Coal Storage and Rehandling Machines.
Link-Belt Company.

Coal Pulverizers.
Fuller Engineering Co.

Coal Crushers.
Link-Belt Co.
Orton & Steinbrenner Co.

Cobalt—98%.
Metal & Thermit Corp.

Coal—Plants for Powdering.
Blaw-Knox Co.
Bonnot Co., The.
Fuller Engineering Co.
Fuller-Lehigh Co.
Quigley Furnace Specialties Co.

Coal Tipples and Trestles.
Link-Belt Company.
Mt. Vernon Bridge Co.

Coal Washers.
Link-Belt Company.

Corks—Tuyere.
McCarthy, Felix.
Homestead Valve Mfg. Co.

Coils and Bends—Pipe.
Pittsburgh Piping & Equip. Co.

Coke.
McKeefrey & Co.
Stewart Iron Co.

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R. H. Beaumont Co.
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Coke Ovens — By-Product—Cross Regenerators.
Hydraulic Press Brick Co.
Koppers Co., The.

Cold Process Water Softeners.
H. S. B. W. Cochrane Corp.

Collectors, Gas.
The Jos. W. Hays Corp.

Cooling Ponds.
Yarnall-Waring Co.

Cooling Systems.
Yarnall-Waring Co.

Columns.
Kratzer & Co., W. N.
Meehan Boiler & Construction Co.

Combustion (CO_2) Recorders.
The Jos. W. Hays Corp.

Compound—Boiler.
United States Graphite Co., The

Compressed Air Locomotives.
Porter Co., H. K.

Compressors—Air.
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Blaw-Knox Co.
De Laval Steam Turbine Co.
General Electric Co.
Hope Eng. & Supply Co.
Ingersoll-Rand Co.
Mesta Machine Co.

Concrete — Steel Forms for Construction.
Blaw-Knox Co.

Complete Foundry Plants.
Whiting Fdry. & Equip. Co.

Compressors—Oxygen and Hydrogen Gas.
International Oxygen Co.

Concrete Construction.
McKee, Arthur G. & Co.

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Standard Scale & Supply Co.

Condensers.
International Oxygen Co.
Riter-Conley Co.

Condensers — Barometric, Surface Jet.
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Mesta Machine Co.
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Condensers—Low Level Srt.
Ingersoll-Rand Co.

Condensers—Surface.
Ingersoll-Rand Co.

Conduits—Elbow.
American Tube & Pipe Bending Co.

Conduits—Electrical.
Youngstown Sheet & Tube Co.

Connectors—Frankel Solderless.
Westinghouse Electric & Mfg. Co.

Constructing Engineers.
Westinghouse, Church, Kerr & Co. Inc.

Construction—Blast Furnace.
Blaw-Knox Co.
Freyn, Brassert & Co.
Laughlin & Sons Co., Alex.
Meehan Boiler & Construction Co.
McClure, G. W. & Son Co.
McKee, Arthur G. Co.
Mt. Vernon Bridge Co.
Smythe & Co., S. R.

Construction—Gas Works.
Blaw-Knox Co.
Morgan Construction Co.
McKee, Arthur G. Co.
Smith Gas Engineering Co.

Construction—Plate.
Blaw-Knox Co.
Meehan Boiler & Construction Co.
Mt. Vernon Bridge Co.

Construction—Structural Iron, Steel
Blaw-Knox Co.
Kratzer & Co., W. N.
Meehan Boiler & Construction Co.
Mt. Vernon Bridge Co.

Construction—Wire Work.
Kratzer & Co., W. N.

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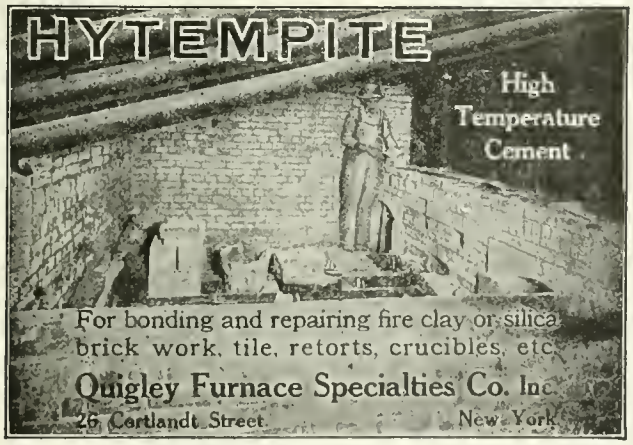
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The Buyers' Guide

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Electric Controller & Mfg. Co.

Controllers—Enclosed Drum Type for Cranes.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Controllers—Electric, for Steel Mill Machinery.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Controllers — Manual, Automatic, Machine Tool, Crane, Coal and Ore Bridges.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Conveyors—Billet.
Link-Belt Company.
Treadwell Eng. Co.

Conveying & Elevating Machinery.
R. H. Beaumont Co.
Link-Belt Co.

Conveyors — Belt, Coal, Chain, Flight, Apron, Etc.
Link-Belt Company.

Conveyors—Hagan Ash
M. H. Detrick Co.

Cooling Beds.
Treadwell Engineering Co.

Cooling Plates.
Blaw-Knox Co.

Cooling Ponds.
Spray Engineering Co.

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Badger, E. B., & Sons Co.
Spray Engineering Co.

Cooling Towers.
Badger, E. B., & Sons Co.
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Copper Tubing.
Wheeler Condenser & Eng. Co.

Core Ovens.
Electric Furnace Construction Co.
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Coupling Boxes.
American Steel Foundries Co.
Garrison Foundry Co., A.
Mesta Machine Co.
National Roll & Foundry Co.
Standard Engineering Co.
Wheeling Mold & Foundry Co.

Couplings—Flexible.
Smith & Serrell.

Couplings—Magnetic.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Couplings—Pipe.
Youngstown Sheet & Tube Co.

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Link-Belt Company.
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Couplings—Rigid.
Smith & Serrell.

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Niles-Bement-Pond Co

Cranes—Electric Traveling, Gantry and Grab Bucket.
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Browning & Co., Victor R.
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Link-Belt Co.
Morgan Engineering Co.
Niles-Bement-Pond Co.
Northern Engineering Works.
Terry, Edward F., Mfg. Co.
Toledo Bridge & Crane Co.
Whiting Fdry. & Equipment Co.

Cranes—Gantry.
Link-Belt Co.
Northern Engineering Works.
Whiting Fdry. Equipment Co.

Cranes—Hand.
Whiting Foundry Equipment Co.

Cranes—Jib and Pillar.
Northern Engineering Works.
Whiting Foundry Equipment Co.

Cranes—Coal and Ash Handling.
Link-Belt Co.
Northern Engineering Works.
Edw. F. Terry Mfg. Co.
Toledo Bridge & Crane Co.
Whiting Foundry Equipment Co.

Cranes—Locomotive.
Browning & Co., Victor R.
Link-Belt Company.
Morgan Engineering Co.
Orton & Steinbrenner Co.
U. S. Crane Co.

Cranes—Pillar.
Champion Engineering Co.
Niles Bement-Pond Co.
Northern Engineering Works.
Toledo Bridge & Crane Co.
Whiting Fdry & Equipment Co.

Cranes—Pneumatic.
Northern Engineering Works.
Whiting Fdry & Equipment Co.

Cranes—Slag Breaking and Handling.
Northern Engineering Works.
Toledo Bridge & Crane Co.

Cranes—Transfer.
Link-Belt Co.
Niles-Bement-Pond Co.
Northern Engineering Works.
Toledo Bridge & Crane Co.
Whiting Fdry. & Equipment Co.

Cranes—Wall and Jib.
Northern Engineering Works.
Toledo Bridge & Crane Co.
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Crushers.
Link-Belt Company
Pennsylvania Crusher Co.

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Blaw-Knox Co.
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Morse Chain Co.

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Drills—Pneumatic & Electric.
Independent Pneumatic Tool Co.

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Link-Belt Company.
Medart Patent Pulley Co.
Morse Chain Co.

Drives—Silent Chain.
Link-Belt Company.

Drives—Mill.
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Fawcus Machine Co.

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Rockwell, W. S. Co.

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Westinghouse Electric & Mfg. Co.

Economizers—Fuel.
Green Fuel Economizer Co., The

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Speer Carbon Co.

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Engineers—Consulting.
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Duff, Samuel E.
Ellis, Frank I.
Freyn & Co.
Laughlin, Alex. & Co.
Meade, Richard K. Co.
Arthur G. McKee Co.
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Moore, W. E. & Co.
Orth, Frank.
Rockwell, W. S. Co.
Searing, C. A.
Shover, Barton R.
Smythe Co., S. R., The.

Engineers—Furnace.
Electric Furnace Construction Co.
Moore, W. E. & Co.
Orth, Frank
Pittsburgh Electric Fur. Corp.
Quigley Furnace Specialties Co.
Rockwell Co., W. S.

Engineers—Open Hearth.
Orth, Frank.

Engineers and Contractors.
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Chambersburg Engineering Co.
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Freyn, Brassert & Co.
Fuller Engineering Co.
Garrison, A., Foundry Co.
Mesta Machine Co.
Mt. Vernon Bridge Co.
McClure Son & Co., G. W.
Arthur G. McKee Co.
Laughlin, Alex. & Co.
Moore, W. E. & Co.
Orth, Frank.
Rockwell, W. S. Co.
Smythe Co., S. R., The.
Standard Engineering Co.
Treadwell Engineering Co.
Westinghouse, Church, Kerr & Co., Inc.
Robinson, Dwight P. Co.

Engineers—Consulting Plant.
Meade, Richard K. Co.

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Taylor Instrument Co.

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Epping-Carpenter Pump Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.

Engines—Gas.
Allis-Chalmers Mfg. Co.
Mesta Machine Co.
United Eng. & Foundry Co.

Engines—Hoisting.
Mesta Machine Co.

Engines — Reversing, Blowing, Pumping, Gas.
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United Eng. & Foundry Co.
Rockwell Co., W. S.

Engines—Steam.
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Mackintosh Hemphill & Co.
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Green Fuel Economizer Co., The

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Mount Union Refractories Co.
Mt. Union, Pa.
Silica Brick—Our Brand Mt. U

Annual Capacity		Capital
1912	12,000,000	$2,000,000.00
1914	36,000,000	
1917	54,000,000	

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Connellsville, Pa.

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Pittsburgh, Pa.

Western Sales Office
208 So. LaSalle St.,
Chicago, Ill.

Eastern Sales Office
Equitable Bldg.,
New York, N. Y.

The Buyers' Guide

Filtering and Circulating Systems for Lubricating Oils.
Bowser & Co., Inc., S. F.

Filters—Oil.
Bowser & Co., Inc., S. F.

Filtering Material.
Celite Products Co.

Fire Brick Cement.
American Refractories Co.
Botfield Specialties Co.
Clinton Metallic Paint Co.
Crescent Refractories Co.
Hagan, Geo. J. Co.
Quigley Furnace Specialties Co.

Fire Clay.
Clinton Metallic Paint Co.
Crescent Refractories.

Fireproof Material Construction.
Clinton Metallic Paint Co.

Fittings—Boiler.
Pittsburgh Piping & Equip. Co.

Fittings—Malleable and Cast Iron.
Pittsburgh Valve, Fdy. & Con. Co.

Flexible Couplings.
Nuttall, R. D. Co.
Smith-Serrell Co., Inc.

Flexible Metallic Packing.
Crane Packing Co.

Flow Meters.
Cochrane, H. S. B. W. Corp.
Republic Flow Meters Co.

Flour-Spar.
Matthew Addy Co., The.

Flue Gas Analyzers.
The Jos. W. Hays Corp.

Forgings.
Biehl Iron Works, Inc.
Hagan, Geo. J. Co.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.
Kratzer & Co., W. N.
Mesta Machine Co.
Morgan Engineering Co.
Penn Foundry & Mfg. Co.

Forging Presses.
Garrison Foundry Co., A.
Morgan Engineering Co.
Niles-Bement-Pond Co.

Forms—Steel—for Concrete Construction.
Blaw-Knox Co.

Foundry Advisers.
McLain's System, Inc.

Frames—Open Hearth.
Blair Engineering Co.
Blaw-Knox Co.
National Roll & Foundry Co.

Friction Blocks.
Morgan Construction Co

Foundry Equipment.
Pittsburgh Valve, Fdy. & Con. Co.
Whiting Foundry Equip. Co.

Fuel Economizers.
Green Fuel Economizer Co., The

Fuel Oil.
Keystone Lubricating Co.
Texas Co.

Furnace Alloys.
Stewart Iron Co.

Furnaces — Annealing and Case Hardening.
Electric Furnace Construction Co.
Fuller Engineering Co.
W. S. Rockwell Co.

Furnace Builders.
American Industrial Eng. Co.
Blair Engineering Co.
Freyn, Brassert & Co.
Fuller Engineering Co.
Hagan, Geo. J. Co.
Hydraulic Press Brick Co.
Laughlin, Alex. & Co.
Miller, W. R. Co., The
McClure Son & Co., G. W.
Arthur G. McKee Co.
Mt. Vernon Brick Co.

Pittsburgh Electric Fur. Corp.
Pittsburgh Furnace Co.
Moore, M. E. & Co.
Rockwell, W. S. Co.

Smythe Co., S. R., The.

Furnace Equipment.
Blaw-Knox Co.
Rockwell, W. S. Co.

Furnaces—Forging, Heat Treating.
Hagan, Geo. J. Co.
Leeds & Northrup Co.
Rockwell W. S. Co.

Furnaces—Electric.
Electric Furnace Construction Co.
Hamilton & Hansell, Inc.
Leeds & Northrup Co.

Pittsburgh Electric Fur. Corp.
Pittsburgh Furnace Co.
Moore, M. E. & Co.
Quigley Furnace Specialties Co.
W. S. Rockwell Co.

Furnace Engineers.
Moore, M. E. & Co.

Pittsburgh Electric Fur. Corp.
Pittsburgh Furnace Co.

Furnaces—Heating.
Freeman Fire Brick Co.
Rockwell, W. S. Co.

Furnace Insulation.
Celite Products Co.
Quigley Furnace Specialties Co.

Furnaces—Lead, Pot and Muffle Annealing, Wire Mill.
Morgan Construction Co.
Rockwell W. S. Co.

Furnaces—Malleable.
Whiting Foundry Equipment Co.

Furnaces—Metallurgical.
Fuller Engineering Co.
Moore, M. E. & Co.

Pittsburgh Electric Fur. Corp.
Pittsburgh Furnace Co.
W. S. Rockwell Co.

Furnaces—Reheating.
Morgan Construction Co.
Rockwell, W. S. Co.

Furnaces—Automatic Smokeless.
Murphy Iron Works.
Rockwell, W. S. Co.

Fuses.
Economy Fuse & Mfg. Co.

Fuses—Renewable.
Economy Fuse & Mfg. Co.

Gas Analysis Apparatus.
The Jos. W. Hays Corp.

Gas—Hydrogen and Oxygen.
International Oxygen Co.

Gages, Draft.
The Jos. W. Hays Corp.

Gas Cleaning Plants.
Arthur G. McKee Co.

Gas Collectors.
The Jos. W. Hays Corp.

Gas Producers.
Camden Iron Works.
Chapman Eng. Co.
The Koppers Co.
Laughlin, Alex.
Meehan Boiler & Constr. Co.
Miller, W. R. Co., The
Morgan Construction Co.
Smith Gas Engineering Co.
Smythe, S. R. Co.
Wood, R. D. & Co.

Gas Valves.
Blair Engineering Co.
Felix McCarthy.
Rockwell, W. S. Co.

Gas Volume Meters.
Cutler-Hammer Mfg. Co.

Gas Washers.
Camden Iron Works.
Freyn, Brassert & Co.
Spray Engineering Co

Gas Oven Plants.
Koppers Co., The.

Gasoline and Oil Measuring Tanks and Pumps—Oil.
Bowser & Co., Inc., S. F.

Gasoline Absorption Plants.
The Koppers Co.

Gate Valves for Gas.
Chapman Valve Mfg. Co., The.

Gate Valves—Cast Steel.
Chapman Valve Mfg. Co., The.

Gate Valves—Motor Operated.
Chapman Valve Mfg. Co., The.

Gate Valves—Bronze.
Chapman Valve Mfg. Co., The.

Gauges—Oxygen Pressure.
International Oxygen Co.

Gauges—Pressure, Draft, Volume.
Bristol Co

Gears—Bevel.
Fawcus Machine Co.

Gears—Compensating.
Morse Chain Co.

Gears and Gear Cutting.
Fawcus Machine Co.
Falk Co., The.
Link-Belt Company.
Mackintosh, Hemphill & Co.
Medart Patent Pulley Co.
Mesta Machine Co.
Morse Chain Co.
Nuttall, R. D. Co.
The Simonds Mfg. Co.
Taylor-Wilson Mfg. Co.
United Eng & Foundry Co.
Woodard Machine Co.

Gears—Herringbone.
Falk Co., The.
Fawcus Machine Co.

Gear Guards.
Blaw-Knox Co.

Gears—Spur.
Fawcus Machine Co.

Gears—Spring.
Morse Chain Co.

Gear Shield.
Ironsides Co., The.

Gears—Worm.
Fawcus Machine Co.

General Industrial Construction.
McKee, Arthur G & Co.

Generators—D. C. and A. C.
Allis-Chalmers Mfg. Co.
General Electric Co
Westinghouse Electric & Mfg. Co.

Girders.
Kratzer & Co., W. N.
Meehan Boiler & Constr'n. Co
Mt. Vernon Bridge Co.

Graphite—Boiler, Forging, Lubricant, Ingot Mold.
United States Graphite Co., The.

Grates.
Combustion Eng. Co.

Greases.
Keystone Lubricating Co.
Texas Co., The.
Ironsides Co., The.
Gulf Refining Co.
United States Graphite Co., The.

Grinders—Pneumatic & Electric.
Independent Pneumatic Tool Co.

Grinding and Polishing Machines.
General Electric Co.

Hammers—Board Steam and Steam Drop.
Chambersburg Engineering Co.
Niles-Bement-Pond Co.
United Engineering & Fdy. Co.

Hammer Crushers.
Pennsylvania Crusher Co.

Hammers—Pneumatic Chipping, Calking and Pipe Bending.
Independent Pneumatic Tool Co.

Hauling Locomotives.
General Electric Co.
Westinghouse E. & M. Co.

Heads—Flanged and Dished Boiler.
Blaw-Knox Co

Heads—Steel, Flanged and Dished.
Treadwell Construction Co.

Hearth Jackets.
Blaw-Knox Co.

Heater.
Robert Gordon, Inc.

Heaters—(Electric), Air, Space, Water.
Cutler-Hammer Mfg. Co.

Heat Insulation.
Celite Products Co.
Clinton Metallic Paint Co.
Quigley Fur. Spec. Co., Inc.

Heat Treating Furnaces.
Electric Furnace Const'n. Co.

Heat Treatment.
Nuttall, R. D. Co.

Heatmeter.
Bristol Co.
Falk Co., The.

Heating and Ventilating Apparatus.
Robert Gordon, Inc.

Herringbone Gears.

Hoists.
Link-Belt Co.
Niles-Bement-Pond Co.
Whiting Foundry Equipment Co.

Hoists—Air.
Ingersoll-Rand Co.
Northern Engineering Works.

Hoists—Electric.
Alliance Machine Co.
Allis-Chalmers Mfg. Co.
Browning & Co., Victor R.
Link-Belt Company.
Morgan Engineering Co.
Niles-Bement-Pond Co.
Northern Engineering Works.
Toledo Bridge & Crane Co.
Vulcan Iron Works.

Hoists—Mining.
Vulcan Iron Works.

Hoists—Monorail.
Link-Belt Co.
Northern Engineering Works.

Hoists—Portable.
Vulcan Iron Works.

Hoists and Portable Floor Crane.
Canton Foundry & Machine Co.

Hoists—Skip.
Link-Belt Company.

Hoists—Pneumatic.
Independent Pneumatic Tool Co.

Holders—Gas.
Camden Iron Works.
Morgan Construction Co.
Smith Gas Engineering Co.

Holders—Pneumatic.
Independent Pneumatic Tool Co.

Hot Blast Stoves.
McKee, Arthur G. & Co.

Hot Process Water Softeners.
H. S. B. W. Cochrane Corp.

Hoops.
West Leechburg Steel Co.
Youngstown Sheet & Tube Co.

Hose—Pneumatic.
Independent Pneumatic Tool Co.

Hydraulic Machinery.
Allis-Chalmers Mfg. Co.
Birdsboro Steel Fdy. & Mch Co.
Camden Iron Works.

Hydraulic Valves.
Spray Engineering Co.
Yarnall-Waring Co.

Hydrants.
Chapman Valve Mfg. Co., The.

Hydraulic Operated Gate Valves.
Chapman Valve Mfg. Co., The.

Hydraulic Packing.
Crane Packing Co.

Illuminators.
Hommel, Ludwig Co.

Indicators—Continuous, Open or Closed Card.
Trill Indicator Co.

Indicators—Draft, Pressure, Velocity.
Trill Indicator Co.

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Hommel, Ludwig Co.

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Penn Foundry & Mfg. Co.
Valley Mould & Iron Corp.
Wheeling Mold & Fdy. Co.

Inhalator—Oxygen.
Mine Safety Appliances Co.

Instruments—Efficiency.
Bristol Co., The.
Leeds & Northrup Co.

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SPUR WORM BEVEL GEARS
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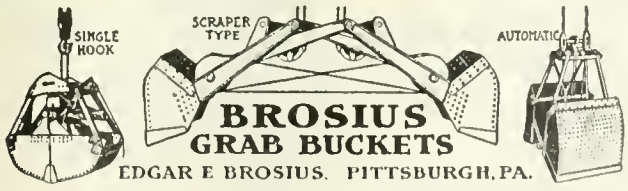
American Industrial Eng. Co., Monadnock Blk., Chicago, Illinois



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PITTSBURGH FURNACE COMPANY,
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The Buyers' Guide

Yarnall-Waring Co.

Instruments—Indicating and Recording.
Bristol Co., The.
The Jos. W. Hays Corp.
Leeds & Northrup Co.
Yarnall-Waring Co.

Insulating Materials—Heat.
Celite Products Co.
Clinton Metallic Paint Co.
Quigley Furnace Specialties Co.

Insulating Brick and Powder.
Celite Products Co.
Clinton Metallic Paint Co.
Quigley Furnace Specialties Co.

Insulators—Electric.
Oeters, Edgar O. Co.,

Iron Body Bronze Mounted Gate Valves.
Chapman Valve Mfg. Co., The.

Iron and Iron Ore.
Camden Iron Works.
Cleveland-Cliffs Iron Co.
McKeefrey & Co.
Stewart Iron Co.
Tod-Stambaugh Co.

Iron Casings.
Valley Mould & Iron Corp.

Joints.
Metal & Thermit Corp.

Kerosene.
Sloan & Zook.

Kilns—Cement.
Blaw-Knox Co.
Fuller-Lehigh Co.

Kilns—Rotary.
Vulcan Iron Works.

Koppax Black Paint.
Koppers Products Co.

Ladles.
Biehl Iron Works, Inc.
Birdsboro Steel Fdy. Mch. Co.
Blaw-Knox Co.
Camden Iron Works.
Meehan Boiler & Constrn. Co.
Whiting Foundry Equip. Co.

Lamps—Storage Battery.
Federal Sign System.

Lathes—Roll.
Garrison Foundry Co., A.
Mesta Machine Co.
Niles-Bement-Pond Co.
Pittsburgh Rolls Corporation.
Standard Eng. Co.
United Engineering & Fdy. Co.
United States Graphite Co., The

Lead.
United States Graphite Co., The

Lectromelt Rapid Steel Furnaces.
Pgh. Electric Furnace Corp.

Lifting Magnets.
Cutler-Hammer Mfg. Co.
Ohio Electric and Controller Co.

Lighting Systems.
Hommel, Ludwig Co.

Lime Kilns.
Meade, Richard K. Co.

Limestone.
McKeefry & Co.

Limestone—Dryers and Pulverizers.
Fuller-Lehigh Co.
Pennsylvania Crusher Co.
Quigley Fur. Spec. Co., Inc.

Linings—Cupola.
Amer. Enam. Brick & Tile Co.
Ashland Fire Brick Co.
Brighton Fire Brick Co.
Clearfield Fire Brick Co.
Dover Fire Brick Co.
Harbison-Walker Ref. Co.
Kier Fire Brick Co.
Manown Mfg. Co.
Mutton Hollow Fire Brick Co.
Pyro Clay Products Co.
Quigley Furnace Specialties Co.
Solsson, Jos., Fire Brick Co.
Harbison-Walker Ref. Co.

Linings—Ladle.
Amer. Enam. Brick & Tile Co.
Ashland Fire Brick Co.
Brighton Fire Brick Co.
Clearfield Fire Brick Co.
Dover Fire Brick Co.
Harbison-Walker Ref. Co.
Kier Fire Brick Co.
Manown Mfg. Co.
Pyro Clay Products Co.
Mutton Hollow Fire Brick Co
Quigley Furnace Specialties Co.
Solsson, Jos., Fire Brick Co.
Taylor, Chas. P.

Liquid Level.
Bristol Co.

Lubricants.
Gulf Refining Co.

Loaders — Wagon Coal, Crushed Stone, Rock, Ore, Ashes, Etc.
Link-Belt Company.

Locomotives and Special Cranes.
Orton & Steinbrenner Co.
U. S. Crane Co.

Locomotives—Electric.
Atlas Car & Mfg. Co.
Baldwin Locomotive Works.
General Electric Co.
Vulcan Iron Works.
Westinghouse Elec. & Mfg. Co.

Locomotives — Steam, Compressed Air, Storage Steam.
Porter, H. K. Co.
Baldwin Locomotive Works.
Vulcan Iron Works.

Locomotives—Storage Battery.
Atlas Car & Mfg. Co.

Lubricants—Gear, Wire Rope, Etc.
Gulf Refining Co.
Keystone Lubricating Co.
Texas Co.
Ironsides Co., The.
United States Graphite Co., The

Machinery—Clay.
Phillips & McLaren Co.

Machinery—Hydraulic.
Allis-Chalmers Mfg. Co.
Birdsboro Steel Fdy. & Mch. Co.
Chambersburg Engineering Co.
Mesta Machine Co.
Niles-Bement-Pond Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.

Machinery—Milling.
Cutler-Hammer Mfg. Co.
Niles-Bement-Pond Co.

Machinery—Rolling Mill.
Birdsborn Steel Fdy & Mch. Co.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Construction Co.
Morgan Engineering Co.
National Roll & Foundry Co.
Phillips & McLaren Co.
Pittsburgh Rolls Corporation.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.
Wheeling Mold & Foundry Co.
Woodard Machine Co.
Youngstown Fdy. & Mch. Co.

Machinery—Transmission (Power).
Link-Belt Co.
Morse Chain Co.

Machinery—Special.
Cutler-Hammer Mfg. Co.
Garrison, A., Foundry Co.
Niles-Bement-Pond Co.
Southwark Foundry & Mch. Co.
Treadwell Engineering Co.
Simonds Mfg. Co., The.
United Engineering & Fdy. Co.
Woodard Machine Co.

Machinery—Tin Plate.
Garrison, A., Foundry Co.
Mesta Machine Co.
Northern Engineering Works.

Machinery—Transmitting.
Link-Belt Company.
Mesta Machine Co.
Morse Chain Co.

Machinery—Wire Drawing, Wire and Rivet Works.
Morgan Construction Co.
Shuster Co., F. B.

Machinery and Supplies—Mining.
Meehan Boiler & Constr'n. Co.

Machinery—Wire Mill.
Morgan Construction Co.

Machinery—Tin Plate.
Garrison Foundry Co., A.
Mesta Machine Co.
Northern Engineering Works.

Machines—Straightening.
Medart Patent Pulley Co.
Morgan Construction Co.
Niles-Bement-Pond Co.
Shuster Co., F. B.

Machines—Testing.
Riehle Brothers Co.

Machinists.
Pittsburgh Valve, Fdy. & Con. Co.

Magnesia Brick.
American Refractories Co.

Magnesite.
American Refractories Co.

Magnetic Clutches, Brakes, Separators.
Cutler-Hammer Mfg Co.

Magnets—Electric Lifting.
Browning Co.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.
Ohio Electric & Controller Co.

Manganese—Pure.
Metal & Thermit Corp.

Manganese—Copper.
Metal & Thermit Corp.

Mattocks.
Oliver Iron & Steel Co.

Mechanical Gas Producers.
Miller, W. R. Co., The

Melting and Refining Furnaces.
Crowley, John A.

Metal Cutting Saws.
Hunter Saw & Machine Co.
Pittsburgh Saw & Mfg. Co.

Metal Brazing.
Pittsburgh Metal Brazing Co.

Metal—Bearing.
Allen, A., & Son.
Damascus Bronze Co.
Keystone Bronze Co.
Lubricating Metal Co.

Metals—Babbitt.
Allen, A., & Son.
Damascus Bronze Co.
Keystone Bronze Co.
Lubricating Metal Co.

Metallurgical Installations—Complete.
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Metalkase Magnesite Brick—McCallum Patent.
Harbison-Walker Refract. Co.

Metallic Gaskets.
Crane Packing Co.

Metallic Packing.
Crane Packing Co.

Meters—Flow.
Republic Flow Meters Co.

Meters—V-Notch (Independent)
H. S. B. W. Cochrane Corp.

Meters—Gas and Air.
Bacharach Industrial Inst. Co.
Cutler-Hammer Mfg. Co.

Meters for Oil—Kerosene, Gasoline.
Bowser, S. F. & Co., Inc.

Meters—Recording.
Bristol Co., The.
Brown Instrument Co.
Leeds & Northrup Co.
Yarnall-Waring Co.

Meters—Weighing.
H. S. B. W. Cochrane Corp.

Metering Heaters.
H. S. B. W. Cochrane Corp.

Metals—Non-Ferrous.
Allen, A., & Son.
Damascus Bronze Co.
Metal & Thermit Corp.

Mill Brasses.
Acme Brass Foundry Co.

Mill Bearings—Roller.
Hyatt Roller Bearing Co.
Morgan Construction Co.

Mills—Continuous Rolling.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Pittsburgh Iron & Steel Fdys. Co.
Standard Eng. Co.
Treadwell Engineering Co.
United Eng. & Foundry Co.

Mill Drives.
Falk Co., The.
Fawcus Machine Co.

Mills—Blooming, Universal, Plate, Sheet, Tin and Bar.
Treadwell Engineering Co.

Mills—Wire, Complete Equipment.
Morgan Construction Co.

Mineral Seal.
Sloan & Zook.

Mixers—"Blaw."
Blaw-Knox Co.

Molds—Ingot.
Valley Mould & Iron Co.
Penn Mold & Mfg. Co.
Wheeling Mold & Foundry Co.

Molybdenum.
Metal & Thermit Corp.

Monorail Systems Electric.
Link-Belt Company.

Monorails—Overhead.
Link-Belt Company.
Niles-Bement-Pond Co.
Whiting Foundry Equipment Co.

Motors—Electric Steel Mill.
Allis-Chalmers Mfg. Co.
General Electric Co.
Westinghouse Electric & Mfg. Co.

Motor Operated Brakes.
Cutler-Hammer Mfg. Co.

Mud Guns and Holding Down Machines.
McCarthy, Felix.

Nails.
Youngstown Sheet & Tube Co.

Neutrals.
Sloan & Zook.

Nodulizing Kilns.
Vulcan Iron Works.

Nozzles—Spray.
Schutte & Koerting Co.
Spray Engineering Co.
Yarnall-Waring Co.

Oils—Engine.
Gulf Refining Co.
Ironsides Co.
Keystone Lubricating Co.
Texas Co.

Oil Engines.
Ingersoll-Rand Co.

Oils—Steam Cylinder Oils.
Gulf Refining Co.

Oil Filters.
Bowser, S. F. & Co., Inc.

Oil Meters.
Bowser, S. F. & Co., Inc.

Oil Packing.
Crane Packing Co.

Oil Pumps.
Bowser S. F. & Co., Inc.

Oil Refineries.
Treadwell Construction Co.

Oil System Accessories.
Richardson-Phenix Co.

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Bowser, S. F. & Co., Inc.

Oil Tanks.
Bowser, S. F. & Co., Inc.

Open Feed Water Heaters and Receivers.
H. S. B. W. Cochrane Corp.

Open Feed Water Heaters.
H. S. B. W. Cochrane Corp.

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McKeefrey & Co.
Stewart Iron Co.
Tod-Stambaugh Co.

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Electric Furnace Construction Co.

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SOFTENING & FILTRATION
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ALL INDUSTRIAL USES
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The Buyers' Guide

Ore, Coal and Ash Handling Equipment.
Haywood Co.
Link-Belt Co.
McKee, Arthur G & Co.

Ore Roasting Kilns.
Vulcan Iron Works.

Packing.
Crane Packing Co.
Green Tweed Co.

Paints—Metal and Wood.
Clinton Metallic Paint Co.
Koppers Products Co.
United States Graphite Co., The

Patents.
Siggers, E. G.
Whitaker, Norman T.

Penstocks.
Blair Engineering Co.
Blaw-Knox Co.
National Roll & Fdy. Co.
Treadwell Construction Co.

Picks.
Oliver Iron & Steel Co.

Pickling Tables.
Link-Belt Company.

Pig Iron.
McKeefrey & Co.
Stewart Iron Co.
Tod-Stambaugh Co.

Pile Drivers.
Vulcan Iron Works.

Pinions—Mill.
American Steel Foundries Co.
Birdsboro Steel Fdy. & Mch. Co.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
National Roll & Foundry Co.
Nuttall, R. D. Co.
Pittsburgh Iron & Steel Fdys. Co.
Standard Engineering Co.
Otis Steel Co., The.
Simonds Mfg. Co.
United Eng. & Foundry Co.
Wheeling Mold & Foundry Co.
Woodard Machine Co.

Pipe.
Pittsburgh Piping & Equip. Co.
Youngstown Sheet & Tube. Co.

Pipe—Bends and Coils.
American Tube & Pipe Bending Co
Pittsburgh Piping & Equip. Co.
Taylor-Wilson Mfg. Co.

Pipe—Riveted Steel.
Blaw-Knox Co.
Meehan Boiler & Constr'n Co

Pipe—Wrought Iron.
Pittsburgh Piping & Equip. Co
Reading Iron Co.
Youngstown Sheet & Tube Co.

Piping.
Pittsburgh Piping & Equip. Co
Pittsburgh Valve, Fdy. & Con. Co.

Pipe Covering—Asbestos and Magnesia.
Celite Products Co
Quigley Furnace Specialties Co.

Pipe Cutting and Threading Machines.
Standard Engineering Co.
Pittsburgh Piping & Equip. Co.
Taylor-Wilson Mfg. Co.

Pipe—Fittings.
Pittsburgh Valve, Fdy. & Con. Co.

Pipe Lines—Riveted Steel.
Treadwell Construction Co

Pipe Mill Machinery.
Garrison, A., Foundry Co.
Pittsburgh Piping & Equip. Co.
Standard Engineering Co.
Taylor-Wilson Mfg. Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.

Piston Rods.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.

Plate and Structural Iron Work.
Camden Iron Works.
Enston Car & Construction Co.
Kratzer, W. N. & Co.
Otis Steel Co.
Toledo Bridge & Crane Co.

Plumbago.
United States Graphite Co., The

Pneumatic Tools.
Ingersoll-Rand Co.
Independent Pneumatic Tool Co.

Portable Floor Cranes and Hoists.
Easton Foundry & Machine Co.

Portable Track.
Enston Car & Construction Co.

Ports—Open Hearth.
Blair Engineering Co.
Blaw-Knox Co.
Birdsboro Steel Fdy. & Mch. Co.
National Roll & Fdy. Co.

Pots, Annealing—Forge and Hammer.
Kellogg, M. W. Co., The.
Quigley Furnace Specialties Co.

Pots, Annealing—Lap Welded.
Kellogg, M. W. Co., The.

Pots—Cinder Slag.
Trendwell Engineering Co.

Power House Conveyors.
Link-Belt Company.

Power Plants.
McKee, Arthur G. & Co.

Power Transmitting Machinery.
Link-Belt Co.
Trendwell Engineering Co.

Powdered Coal Equipment.
American Industrial Eng. Co.
Fuller Engineering Co.
Fuller-Lehigh Co.
Quigley Furnace Specialties Co.
Stroud, E. H. & Co.

Powdered Coal Plants—Complete.
Fuller Engineering Co.
Quigley Furnace Specialties Co.

Precision Meters.
Cochrane H. S. B. W. Corp.

Presses—Forging.
Camden Iron Works.
Canton Foundry & Machine Co.
Chambersburg Engineering Co.
Garrison, A., Foundry Co.
Mesta Machine Co.
Morgan Engineering Co.
Niles-Bement-Pond Co.
United Engineering & Fdy. Co.

Presses—Hydraulic.
Birdsboro Steel Fdy. & Mch. Co.
Camden Iron Works.
Canton Foundry & Machine Co.
Chambersburg Engineering Co.
Garrison, A., Foundry Co.
Mesta Machine Co.
Niles-Bement-Pond Co.
United Engineering & Fdy. Co
Vulcan Iron Works.

Presses—Rail Straightening.
Canton Foundry & Machine Co.
Garrison, A., Foundry Co.
Morgan Construction Co.
Niles-Bement-Pond Co.

Pressure Packed Valves.
Homestead Valve & Mfg. Co.
Spray Engineering Co.
Yarnall-Waring Co.

Pressure and Vacuum.
Bristol Co.

Producers—Gas Automatic.
Wood, R. D. & Co.
Miller, W. R. Co., The

Producers—Gas.
Blaw-Knox Co.
Camden Iron Works
Chapman Eng. Co.
Laughlin, Alex & Co.
Miller, W. R. Co., The
Morgan Construction Co
Smith Gas Engineering Co., The
S. R. Smythe Co., The.
Wood, R. D. & Co.

Pulleys and Clutches.
Link-Belt Company.
Medart Patent Pulley Co
Mesta Machine Co.
Morse Chain Co

Pulverizers.
American Industrial Eng Co.
Fuller Engineering Co.
Fuller-Lehigh Co.
Pennsylvania Crusher Co.
Quigley Furnace Specialties Co.
Stroud, E. H. & Co.

Pulverized Coal Equipment.
American Industrial Eng. Co.
Bonnot Co., The.
Combustion Eng. Co.
Fuller Engineering Co.
Fuller-Lehigh Co.
Meade, Richard K. Co.
Quigley Furnace Specialties Co.
Stroud, E. H. & Co.

Pumps—Air.
Ingersoll-Rand Co.

Pumps.
Allis-Chalmers Mfg. Co.
Birdsboro Steel Fdy. & Mch. Co.
DeLaval Steam Turbine Co.
Mesta Machine Co.
Richardson-Prenix Co.

Pumps—Centrifugal.
Allis-Chalmers Mfg. Co.
Camden Iron Works.
DeLaval Steam Turbine Co.

Pumps—Electric.
Allis-Chalmers Mfg. Co.

Pumps (Hand or Power) — Oil, Gasoline.
Bowser, S. F. & Co., Inc.

Pumps—Hydraulic.
Chambersburg Engineering Co.

Punches—High Speed, Horizontal Multiple.
Niles-Bement-Pond Co.

Pyrometers—Optical.
Leeds & Northrup Co.

Pyrometers—Indicating, Recording
Bacharach Industrial Inst. Co.
Bristol Co., The.
The Jos. W. Hays Corp.
Leeds & Northrup Co.
Thwing Instrument Co.

Quick Closing Emergency Trip Railroad Scales.
Standard Scale & Supply Co.

Railway Equipment.
Whiting Fdry. Equipment Co.

Recording Draft Gages.
The Jos. W. Hays Corp.

Recording Thermometers.
Bristol Co.
The Jos. W. Hays Corp.
Leeds & Northrup Co.
Taylor Instrument Co.

Recording Instruments.
Bacharach Industrial Inst. Co.
Bristol Co.
The Jos. W. Hays Corp.
Leeds & Northrup Co.

Recording CO_2 Machines.
The Jos. W. Hays Corp.

Reels—Wood and Iron, Wire Mills.
Morgan Construction Co

Refractory Linings and Cement.
Botfield Specialties Co.
Crescent Refractories Co.
Quigley Furnace Specialties Co.

Regulators.
Bristol Co.

Regulators—Automatic.
Bristol Co.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg Co
Leeds & Northrup Co.

Regulators, Dampers.
The Engineer Co.

Relays—Field Rheostat.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Renewable Fuses.
Economy Fuse & Mfg. Co.
Hommel, Ludwig & Co.

Resistance—Cast Grid and Coil.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg Co

Rheostats — Motor Field, Motor Starting.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg Co

Riveters.
Chambersburg Engineering Co.
Mesta Machine Co.
Niles-Bement-Pond Co

Rivet Cutting Gun.
Riveted Piping.
Meehan Boiler & Constr. Co.
Rivet Cutting Gun Co.

Rocking Mill.
Mackintosh-Hemphill Co.

Rod Mills.
Standard Engineering Co.
Treadwell Engineering Co.

Rods—Piston.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.

Rolls—Crushing.
Link-Belt Company.
Pennsylvania Crusher Co.
Stroud, E. H. & Co.

Rolls—Sand, Chilled and Steel.
American Steel Foundries.
Birdsboro Steel Fdy. & Mch. Co.
Duquesne Steel Foundry Co.
Garrison, A., Foundry Co.
Lewis Foundry & Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
National Roll & Foundry Co.
Otis Steel Co.
Pittsburgh Iron & Steel Fdys. Co.
Pittsburgh Rolls Corporation.
Standard Engineering Co.
Canton Steel Foundry Co., The.
United Engineering & Fdy. Co.
Wheeling Mold & Foundry Co.
Youngstown Fdy. & Mch. Co.

Roll Bearings.
Damascus Bronze Co.
Keystone Bronze Co.

Roll Lathes.
Standard Engineering Co.

Roll Neck Lubricant.
Ironsides Co., The.

Roller Bearings.
American Roller Bearing Co.
Hyatt Roller Bearing Co.

Rotary Kilns.
Vulcan Iron Works.

Rotating Electric Furnaces.
American Metallurgical Corp.

Rolling Mill Machinery.
Lewis Foundry & Machine Co.
Mesta Machine Co.
National Roll & Foundry Co.
Standard Engineering Co.
Treadwell Engineering Co.

Roofs and Buildings—Iron.
Kratzer, W. N. & Co.
Mt. Vernon Bridge Co.

Rope Dressing.
Keystone Lubricating Co.
Link-Belt Company.
Texas Co.

Runners.
Valley Mould & Iron Corp.

Runner Brick.
Courtney Fire Brick Co.
Manown Manufacturing Co.
Pittsburgh Coal Co.

Safety Appliances.
Mine Safety Appliances Co.

Sand Filters.
H. S. B. W. Cochrane Corp.

Sand—Refractory.
Quigley Furnace Specialties Co.

Sand Rammers—Pneumatic
Independent Pneumatic Tool Co.

Saws — Metal Cutting, Inserted Tooth.
Hunter Saw & Machine Co.
Pittsburgh Saw & Mfg. Co
Standard Engineering Co.

Scales—Automatic Dial, Railroad Track, Special.
Standard Scale & Supply Co.

Scales — Rolling Mill, Furnace, Stock Charging.
Standard Scale & Supply Co.

Co-operate:—Refer to The Blast Furnace and Steel Plant

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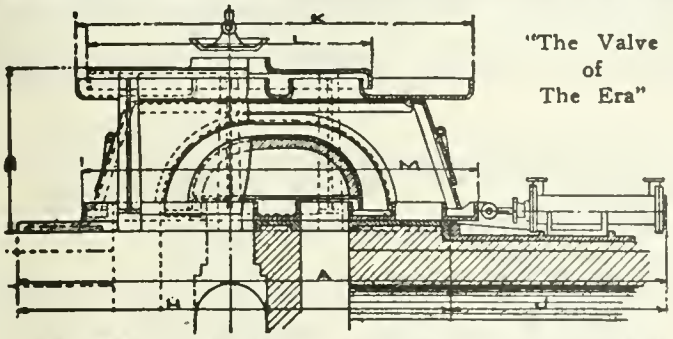

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The Buyers' Guide

Scientific Instruments.
Bristol Co.
Leeds & Northrup Co.

Screen—Perforated Metal.
Link-Belt Company.

Screens—Bar, Rotary or Shaking.
Link-Belt Company.

Screw Stock.
Standard Gauge Steel Co.
Union Drawn Steel Co.
West Leechburg Steel Co.

Separators—Compressed Air.
H. S. B. W. Cochrane Corp.

Separators—Steam.
Cochrane H. S. B. W. Corp.

Separators—Magnetic.
Cutler-Hammer Mfg. Co.

Separators—Oil.
H. S. B. W. Cochrane Corp.

Shafting.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.
Medart Patent Pulley Co.
Standard Gauge Steel Co.
Union Drawn Steel Co.
West Leechburg Steel Co.

Shaft Couplings.
Link-Belt Co.
Smith & Serrall.

Shaft Hangers.
Medart Patent Pulley Co.

Shaking Screens.
Link-Belt Company.

Shapes—Special Steel.
Standard Gauge Steel Co.
Union Drawn Steel Co.
West Leechburg Steel Co.

Shears—Angle and Plate.
Camden Iron Works.
Canton Foundry & Machine Co.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Niles-Bement-Pond Co.
Phillips & McLaren Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineerig & Fdy. Co.

Shear Blades.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.

Shears—Billet, Bloom and Slab.
Camden Iron Works.
Canton Foundry & Machine Co.
Garrison, A., Foundry Co.
Lewis Foundry & Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Niles-Bement-Pond Co.
Phillips & McLaren Co.
Quickwork Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.
Woodard Machine Co.

Shears—Guillotine.
Canton Foundry & Machine Co.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Phillips & McLaren Co.
Quickwork Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.

Shear Knives.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.

Shears—Portable, Motor Driven.
Canton Foundry & Machine Co.
Garrison, A., Foundry Co.
Lewis Foundry & Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Phillips & McLaren Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.

Shears—Scrap, Alligator, Wire.
Camden Iron Works.
Garrison, A., Foundry Co.
Lewis Foundry & Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Phillips & McLaren Co.
Quickwork Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.
Youngstown Fdry. & Mch. Co.

Sheers—Squaring.
Garrison, A., Foundry Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Niles-Bement-Pond Co.
Merchant & Evans Co.
Morgan Engineering Co.
Phillips & McLaren Co.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.

Shearing Machines.
Garrison, A., Foundry Co.
Lewis Foundry & Machine Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Engineering Co.
Phillips & McLaren Co.
Standard Engineering Co.
Treadwell Engineering Co.

Sheets—Steel and Iron.
Otis Steel Co.
Merchant & Evans Co.
Youngstown Sheet & Tube Co.

Signs.
Federal Sign System.

Silent Chain Drives.
Link-Belt Company.
Morse Chain Co.

Sirens.
Federal Sign System.

Silica Brick.
American Refractories Co.
Harbison-Walker Refract. Co.

Silica Clays.
Harbison-Walker Refract. Co.

Silicon.
McKeefrey & Co.
United States Alloys Corp.

Silicon—Ferro.
United States Alloys Corp.

Skip Hoists.
Link-Belt Company.
Treadwell Engineering Co.

Skip Cars.
Atlas Car & Mfg. Co.
Biehl Iron Works, Inc.
Easton Car & Construction Co.
Youngstown Fdy. & Mch. Co.

Slag Cutter.
Rivet Cutting Gun Co.

Sleeves and Nozzles.
Bessemer Brick Co.
Courtney Fire Brick Co.
Pittsburgh Coal Co.
Manown Manufacturing Co.

Sluice Gates.
Chapman Valve Mfg. Co., The.

Smoke Stacks—Steel.
Treadwell Construction Co.

Soaking Pit Covers.
Treadwell Engineering Co.
Wheeling Mold & Foundry Co.

Solder.
Damascus Bronze Co.
Keystone Bronze Co.

Solderless Connectors—Frankel.
Westinghouse Electric & Mfg. Co.

Spares—Open Hearth.
Biehl Iron Works, Inc.

Special Machinery.
Treadwell Engineering Co.

Spindles—Mill.
American Steel Foundries.
Birdsboro Steel Fdy. & Mch. Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Pittsburgh Rolls Corporation.
Standard Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.
Wheeling Mold & Foundry Co.

Spray Nozzles.
Spray Engineering Co.
Yarnall-Waring Co.

Spray Cooling.
Spray Engineering Co.
Yarnall-Waring Co.

Spray Water Cooling Equipment.
Badger, E. B., & Sons Co.
Yarnall-Waring Co.

Spray Air Washing Equipment.
Badger, E. B., & Sons Co.

Sprocket Wheels.
Link-Belt Company.
Medart Patent Pulley Co.
Morse Chain Co.

Sprue Plates.
Valley Mould & Iron Corp.

Stacks—Steel.
Blaw-Knox Co.
Meehan Boiler & Constr. Co.

Steam Packing.
Crane Packing Co.

Stampings—Steel.
West Leechburg Steel Co.

Standings — Water Cooled for Rolling Mill.
Blaw-Knox Co.

Standpipes.
Blaw-Knox Co.

Steam Stack and Cut-off Valve Heaters and Receivers.
H. S. B. W. Cochrane Corp.

Steam Superheaters.
Babcock & Wilcox Co.

Steam and Storage Steam Locomotives.
Porter, H. K. Co.

Steam Specialties.
Nicholson, W. H. & Co.
Yarnall-Waring Co.

Steam Traps.
Homestead Valve Mfg. Co.
Nicholson, W. H. & Co.

Steel—Building and Structural.
Kratzer, W. N. & Co.
Mt. Vernon Bridge Co.
Toledo Bridge & Crane Co.

Steel—Cold Rolled Strip.
Mt. Vernon Bridge Co.
Standard Gauge Steel Co.
Union Drawn Steel Co.
West Leechsburg Steel Co.

Steel Frame Buildings.
Mt. Vernon Bridge Co.

Steel—Lap Weld.
American Tube & Pipe Bending Co.

Steel—Nickel.
Otis Steel Co., The.

Steel Plants.
McKee, Arthur G. & Co.

Steel—Seamless.
American Tube & Pipe Bend. Co.

Steel—Stamping and Drawing.
Mt. Vernon Bridge Co.
Standard Gauge Steel Co.
Union Drawn Steel Co.
West Leechburg Steel Co.

Steel Plate Work.
Graver Corp

Steel Plate Construction—Heavy.
Treadwell Construction Co.

Steel—Structural.
Camden Iron Works.
Kratzer, W. N. & Co.
Mt. Vernon Bridge Co.

Steel—Basic Open Hearth.
Brier Hill Steel Co.

Steel Plate Products—Pressed.
Meehan Boiler & Constr. Co.
Treadwell Construction Co.

Stills.
Blaw-Knox Co.

Stills for Oil Refineries.
Treadwell Construction Co.

Stokers.
Babcock & Wilcox Co., The.
Combustion Eng. Corp.
Hagan, Geo. J. Co.
Murphy Iron Works.
Sanford Riley Stoker Co.
Stroud, E. H. & Co.
Underfeed Stoker Co. of America

Stoker Control System.
The Engineer Co.

Stop and Check Valves.
Golden Anderson Valve Specialty Co.

Stops—Automatic.
Spray Engineering Co.
Yarnall-Waring Co.

Stops—Electric Limit, Etc., for Cranes.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Storage Bins.
McKee, Arthur G. & Co.

Storage and Distributing Systems.
Bowser & Co., S. F.

Stoves—Hot Blast.
Blaw-Knox Co.
Mt. Vernon Bridge Co.
McClure, G. W., Son & Co.
Arthur G. McKee Co.
Smythe, S. R. Co.

Straightening Machines.
Medart Patent Pulley Co.
Morgan Construction Co.
Niles-Bement-Pond Co.
Treadwell Engineering Co.
Shuster, F. B. Co.

Sugar Refineries.
Treadwell Construction Co.

Superheat Cement.
Clinton Metallic Paint Co.

Switchboards—For Cranes.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

Switches—Automatic Float, Knife, Snap.
Cutler-Hammer Mfg. Co.
Electric Controller & Mfg. Co.

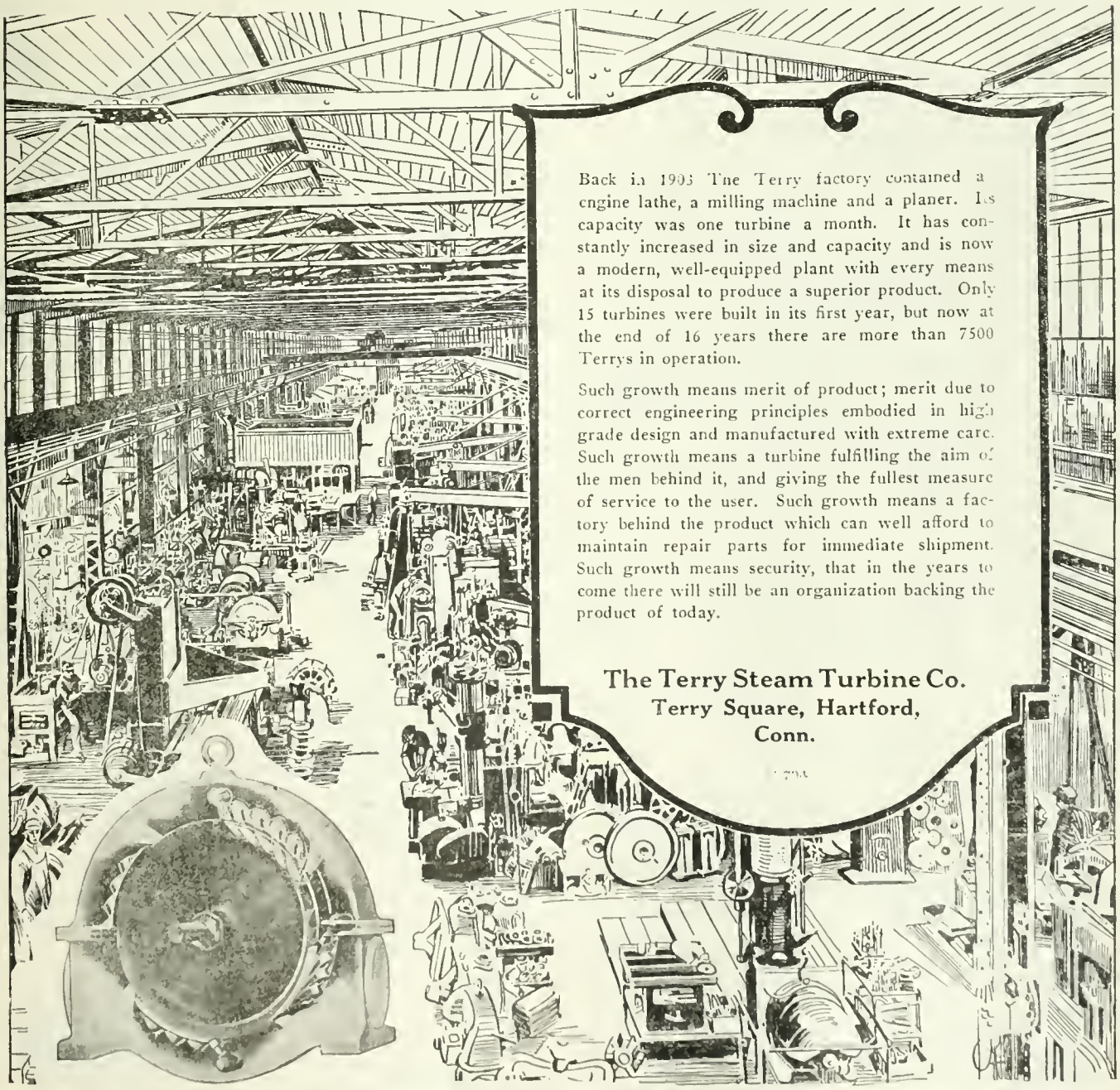
Switches—Magnetic.
Cutler-Hammer Mfg. Co.

Switches—Track.
Easton Car & Construction Co.

Tables—Rolling Mill.
Birdsboro Steel Fdy. & Mch. Co.
Mackintosh, Hemphill & Co.
Mesta Machine Co.
Morgan Construction Co.
Morgan Engineering Co.
Treadwell Engineering Co.
United Engineering & Fdy. Co.
Woodward Machine Co.

THE TERRY TURBINE

is only the name of a product, but behind it lie the important elements of value which only years of experience can produce.



Back in 1903 The Terry factory contained a engine lathe, a milling machine and a planer. Its capacity was one turbine a month. It has constantly increased in size and capacity and is now a modern, well-equipped plant with every means at its disposal to produce a superior product. Only 15 turbines were built in its first year, but now at the end of 16 years there are more than 7500 Terrys in operation.

Such growth means merit of product; merit due to correct engineering principles embodied in high grade design and manufactured with extreme care. Such growth means a turbine fulfilling the aim of the men behind it, and giving the fullest measure of service to the user. Such growth means a factory behind the product which can well afford to maintain repair parts for immediate shipment. Such growth means security, that in the years to come there will still be an organization backing the product of today.

The Terry Steam Turbine Co.
Terry Square, Hartford, Conn.

Co-operate:—Refer to The Blast Furnace and Steel Plant

The Buyers' Guide

Tachometers.
Bristol Co.

Tanks—Air Pressure.
Biehl Iron Works, Inc.
Blaw-Knox Co.
Meehan Boiler & Const'n. Co.

Tanks—Cast Iron.
H. S. B. W. Cochrane Corp.

Tanks—Oil, Gasoline, Kerosene.
Bowser, S. F. & Co., Inc.

Tanks—Storage (Oxygen and Hydrogen.)
International Oxygen Co.

Tanks—Storage and Pressure.
Graver Corp.

Tanks and Towers—Steel.
Easton Car & Construction Co.
Blaw-Knox Co.

Tapping Machines—Blast Furnace.
Southwark Fdry. & Mach. Co.

Tar Extractors.
Smith Gas Engineering Co.

Tar Distilling Plants.
The Koppers Co.

Testing Apparatus for Cylinders.
International Oxygen Co.

Temperature.
Bristol Co.

Temperature Regulators.
Bristol Co.
Leeds & Northrup Co.

Testing Machines.
Bristol Co., The
Riehle Bros. Testing Mch. Co.

Thermit.
Metal & Thermit Corp.

Thermometers—Recording.
Bristol Co., The
Leeds & Northrup Co.

Tile—Locomotive.
Dover Fire Brick Co.

Tin Plate Mill Equipment.
Treadwell Engineering Co.

Tipples—Coal.
Blaw-Knox Co.
Link-Belt Company.
Mt. Vernon Bridge Co.

Titanium.
Metal & Thermit Corp.

Tools.
Biehl Iron Works, Inc.
Camden Iron Works.

Tools—Hydraulic.
Camden Iron Works.

Tools—Roll Turning.
Garrison, A., Foundry Co.
Heppenstall Forge & Knife Co.
National Roll & Foundry Co.
United Engineering & Fdy. Co.
Pittsburgh Rolls Corporation.
Treadwell Engineering Co.
Standard Engineering Co.

Tools—Pneumatic.
Ingersoll-Rand Co.
Independent Pneumatic Tool Co.

Tools—Electric.
Independent Pneumatic Tool Co.

Towers—Transmission, Galvanized
Kratzer, W. N. & Co.

Transformers.
Pittsburgh Transformer Co.

Transfer Tables.
Whiting Foundry Equipment Co

Transmission—Rope.
Link-Belt Company.
Medart Patent Pulley Co.
Mesta Machine Co.
Morse Chain Co.
United Eng. & Foundry Co.

Transmission—Equipment.
Medart Patent Pulley Co.
Link-Belt Company.
Mesta Machine Co.
Morse Chain Co.
United Eng. & Foundry Co

Transmission—Silent Chain.
Chain Belt Co.
Link Belt Company.
Morse Chain Co.

Transmission—Towers.
Blaw-Knox Co.
Kratzer, W. N. & Co.

Traps—Steam, Compressed Air Gas.
Homestead Valve Mfg. Co.
Spray Engineering Co.
Yarnall-Waring Co.

Trimmer Steel.
Heppenstall Forge & Knife Co.
Heppenstall Forge Co.

Trucks.
Atlas Car & Mfg. Co.
Biehl Iron Works, Inc.
Easton Car & Construction Co.
Penn Foundry & Mfg. Co.
Standard Scale & Supply Co.
Whiting Foundry Equipment Co.

Trusses—Roof.
Kratzer, W. N. & Co.
Mt. Vernon Bridge Co.

Tube Cleaners.
Combustion Eng. Co.

Tubes.
American Tube & Pipe Bend. Co.
Youngstown Sheet & Tube Co.

Tubes—Boiler, Superheater.
Youngstown Sheet & Tube Co.

Tumbling Barrels.
Babcock & Wilcox Co., The.
Whiting Foundry Equipment Co.

Tungsten.
Metal & Thermit Corp.

Turbines—Steam.
Allis-Chalmers Mfg. Co.
De Laval Steam Turbine Co.
General Electric Co.
Terry Steam Turbine Co.
Westinghouse Electric & Mfg. Co

Turbines—Power.
De Laval Steam Turbine Co.

Turbo—Blowers and Compressors.
De Laval Steam Turbine Co.
Ingersoll-Rand Co.

Turbo—Generators.
De Laval Steam Turbine Co.
Ingersoll-Rand Co.
Westinghouse Electric & Mfg. Co.

Turntables.
Easton Car & Construction Co.
Link-Belt Company.
Toledo Bridge & Crane Co.
Whiting Foundry Equipment Co.

Under-Feed Stokers.
Murphy Iron Works
Sanford-Riley Stoker Co
Underfeed Stoker Co. of America.

Unions.
McCarthy, Felix.
Homestead Valve Mfg. Co.
Youngstown Sheet & Tube Co.

Vacuum and Draft Gauges.
Bristol Co.

Valves.
American Fdy. & Const'n. Co.
Blair Engineering Co.
Blaw-Knox Co.
Chapman Valve Mfg. Co., The.
Camden Iron Works.
McCarthy, Felix.
Edward Valve & Mfg. Co.
Homestead Valve Mfg. Co.
Hope Engineering & Supply Co.
Pittsburgh Valve, Fdy. & Con. Co.
Rockwell, W. S. Co.
Richardson-Phenix Co.
Smythe, S. R. Co.
Spray Engineering Co.
Yarnall-Waring Co.

Valves—Atmospheric Relief.
H. S. B. W. Cochrane Corp.

Valves—Back Pressure.
H. S. B. W. Cochrane Corp.

Valves—Blow-Off.
Homestead Valve Mfg. Co.
Yarnall-Waring Co.

Valves—Check.
Chapman Valve Mfg. Co., The.
Cochrane, H. S. B. W. Corp.

Valves—Cast Steel.
Homestead Valve Mfg. Co.
Yarnall-Waring Co.

Valves—Gas.
Chapman Valve Mfg. Co., The.

Valves—Hydraulic.
Camden Iron Works.
Chapman Valve Mfg. Co., The.
Homestead Valve Mfg. Co.
Spray Engineering Co.
Yarnall-Waring Co.

Valves—Pump.
Edward Valve & Mfg. Co.

Valves—Non-Return, Stop.
Edward Valve & Mfg. Co.

Valves—Special.
Hope Engineering & Supply Co.
Pittsburgh Valve, Fdy. & Con. Co.
Miller, W. R. Co., The

Valves—Stud, Gas Cylinder.
International Oxygen Co.
Spray Engineering Co.
Yarnall-Waring Co.

Valves—Hydraulically Operated.
Chapman Valve Mfg. Co., The.

Valves and Fittings—Hydraulic.
Chambersburg Engineering Co.
McCarthy, Felix.
Homestead Valve Mfg. Co.
Pittsburgh Valve, Fdy. & Con. Co.
Spray Engineering Co.
Yarnall-Waring Co.

Valves—Motor-Operated.
Chapman Valve Mfg. Co., The.
Spray Engineering Co.
Yarnall-Waring Co.

Valves—Reducing.
Edward Valve & Mfg. Co.

Valves—Regrinding.
McCarthy, Felix.
Homestead Valve Mfg. Co.

Valves—Superheated Steam.
Edward Valve & Mfg. Co.

Valves—Safety.
Edward Valve & Mfg. Co.

Valves—Stop.
Edward Valve & Mfg. Co.

Ventilating Apparatus.
Robert Gordon, Inc.

Wash—Core, Mold.
Quigley Furnace Specialties Co.
United States Graphite Co., The

Washers.
Oliver Iron & Steel Co.
Schutte & Koerting Co.

Water Coolers.
The Jewett Refrigerating Co.

Water Cooling—Apparatus.
Spray Engineering Co.
Yarnall-Waring Co.

Water Filters.
Graver Corp.
Scaife, Wm. B. & Sons Co.

Water Heaters.
Graver Corp

Water Softening and Purifying Systems.
Scaife, Wm. B. & Sons Co.

Water—Intake Screens—Traveling
Chain Belt Co.
Link-Belt Company.

Water Purifier.
Yarnall-Waring Co.

Water Tube Steam Boilers.
Babcock & Wilcox Co., The.
Wickes Brothers C

Wedges.
Oliver Iron & Steel Co.

Welded Specialties and Headers.
Blaw-Knox Co.
Pittsburgh Valve, Fdy. & Con. Co

Welding and Cutting Apparatus—Oxy-Hydrogen.
International Oxygen Co.

Welding.
Blaw-Knox Co.
Metal & Thermit Corp.
Pittsburgh Metal Brazing Co.

Welding—Thermit.
Metal & Thermit Corp.

Wheels.
Atlas Car & Mfg. Co.
Easton Car & Construction Co.
Fuller-Lehigh Co.
Link-Belt Company.
Treadwell Engineering Co.

Wheels—Car.
Easton Car & Construction Co.
Fuller-Lehigh Co.
Treadwell Engineering Co.

Wheels—Fly.
Link-Belt Company.
Mesta Machine Co.
United Engineering & Fdy. Co.

Wheels—Sheave.
Link-Belt Company.
Mesta Machine Co.

Wheels—Sprocket or Traction.
Link-Belt Company.
Morse Chain Co.

Wheels—Steel.
American Steel Foundries.

Wire Rope Shield.
Ironsides Co., The.

Wire Mill Equipment.
American Ind. Eng. Co.

Wire Straightening Machines.
American Industrial Eng. Co.
Medart Patent Pulley Co.
Morgan Construction Co.
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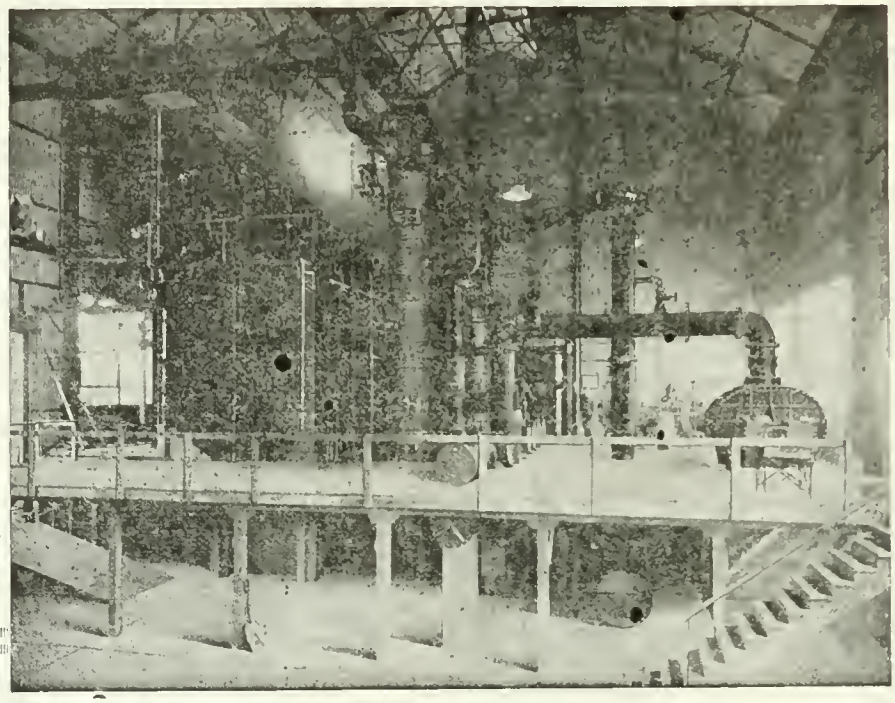
Smith Clean-Gas Producers
MEAN
Central Station Gas Plants

One Place For Coal Delivery.
One Place For Ash Removal.
No Mains to Burn Out.



Automatic Distribution Under Desired Pressure For Use Where and When Wanted.

Typical Installation (Type MB)

Cold, Clean Gas From Smith Producers
Replaces
Natural Gas, Fuel Oil and Stokers

One ton of coal will do as much Heat Treating in ordinary furnaces as 150 gallons of fuel oil.

One ton of coal will do as much High Temperature Heating as 350 gallons of oil if furnaces are made regenerative.

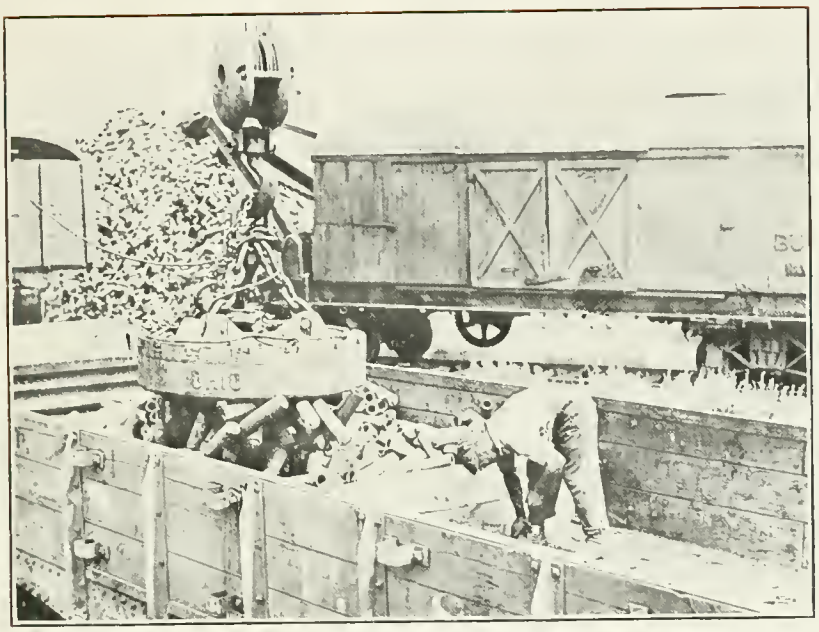
Investigate Now—Installations in Operation.

The Smith Gas Engineering Company
Dayton, U. S. A.

Factories Lexington, Ohio—Dayton.

Sole Canadian Representatives—The Canadian Allis-Chalmers, Ltd., Toronto.

OHIO
LIFTING MAGNETS



No. 5-50" Ohio Magnet unloading scrap at Henry A. Hitner's Sons Company, Philadelphia, Pa.

Terminal Details of Ohio Magnets

The coil lead is a flat strip woven of 930 small copper wires. It is extra flexible and will never break from shock or vibration. Both leads come from the outside edge of the coil and are thoroughly insulated from the case.

This lead is long enough so it can be pulled out through the terminal hole if it must be disconnected. In place it is doubled back on itself and insulated from the walls of the lead cavity by rings of ebony, impregnated asbestos wood.

Bulletin No. 104

The Ohio Electric & Controller Co.

5900 Maurice Avenue — **Cleveland, Ohio**

E.C.&M.
LIFTING MAGNETS

DON'T FORGET

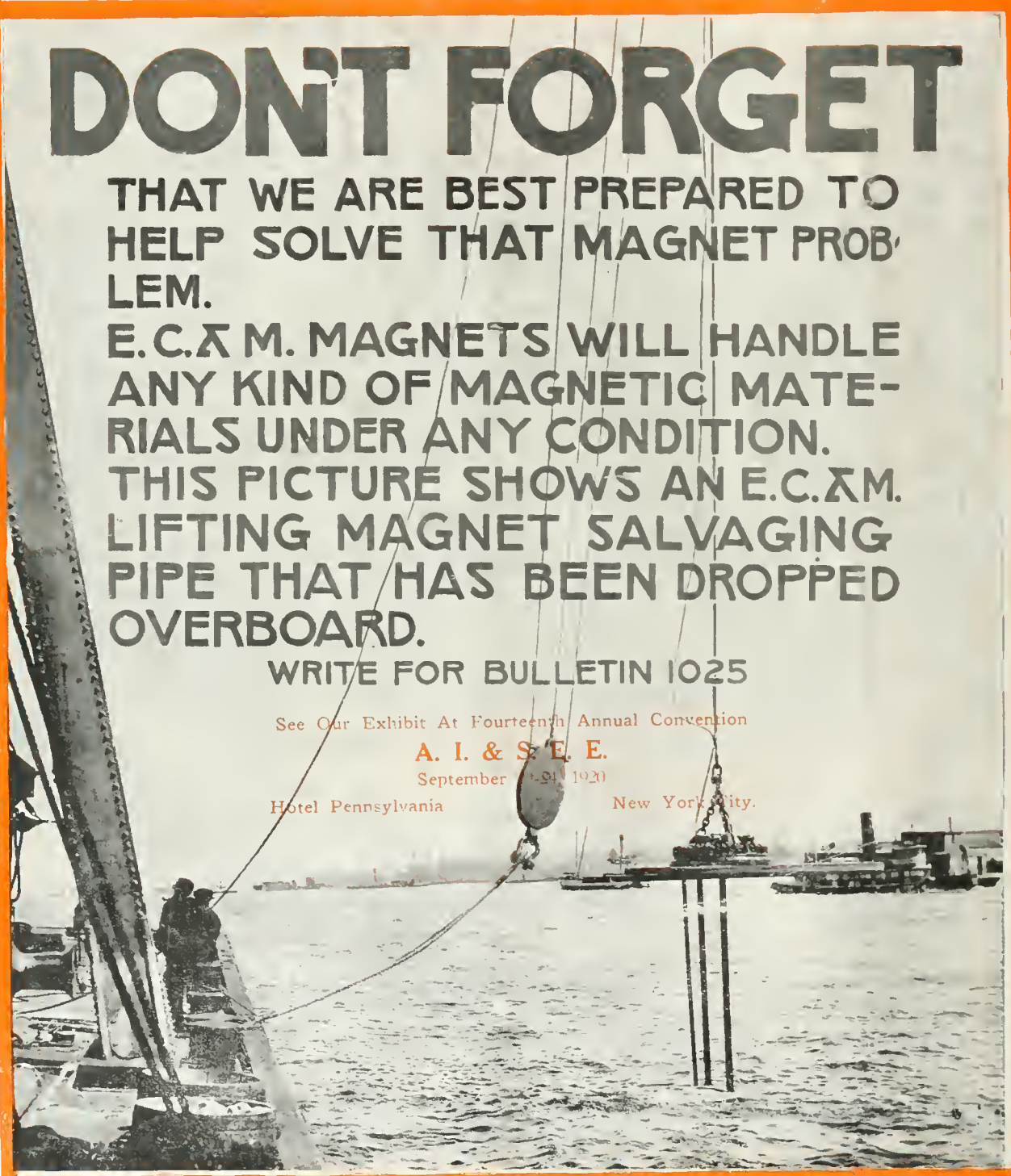
THAT WE ARE BEST PREPARED TO HELP SOLVE THAT MAGNET PROBLEM.

E.C.&M. MAGNETS WILL HANDLE ANY KIND OF MAGNETIC MATERIALS UNDER ANY CONDITION.

THIS PICTURE SHOWS AN E.C.&M. LIFTING MAGNET SALVAGING PIPE THAT HAS BEEN DROPPED OVERBOARD.

WRITE FOR BULLETIN 1025

See Our Exhibit At Fourteenth Annual Convention
A. I. & S. E. E.
September 20-24, 1920
Hotel Pennsylvania New York City.



THE ELECTRIC CONTROLLER & MFG. CO.
CLEVELAND, OHIO.

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SAN FRANCISCO-CALL BLDG.
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DENVER AND SALT LAKE CITY-O H. DAVIDSON EQUIPMENT COMPANY
CHICAGO-CONWAY BLDG
DETROIT-DIME BANK BLDG
TORONTO-TRADERS BANK BLDG
SEATTLE-524 1ST AVE. SOUTH

Co-operate:—Refer to The Blast Furnace and Steel Plant